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Cyprinodon salinus, a New Species of Fish from
Death Valley, California

By ROBERT R. MILLER

DEATH Valley once formed the terminus of an extensive Pleistocene drainage herein referred to as the Death Valley System. This system, lying in eastern California and southwestern Nevada, comprises a number of now isolated valleys and basins of interior drainage, including Owens Valley, the Indian Wells-Searles basin, Panamint Valley, Death Valley, the Amargosa River basin, Pahrump Valley,¹ and the Mohave River basin. Though now much disrupted, most of the complex was integrated into a hydrographic unit during the latter part of Pleistocene time (Gale, 1914; Waring, 1920; Noble, 1926, 1931; Blackwelder, 1933; and others). Lake Manly, the body of water then existing in Death Valley, formed the sump for all the waters of the system. Its two main tributaries, Owens River and the stream formed by the confluence of the Amargosa and Mohave rivers, entered the valley at the southern end. The Amargosa still pours its flood waters onto the salt flat remnant of Lake Manly, but the other tributaries have long since ceased to flow into Death Valley.

The distribution of the fishes of the Death Valley System substantiates the physiographic evidence for the former hydrographic continuity of these basins. The occurrence of the minnow genus *Siphateles* in the Owens and Mohave rivers, of *Cyprinodon* in the Amargosa-Death Valley region and Owens Valley, and of the cyprinodont, *Empetrichthys*, in Pahrump Valley and in Ash Meadows of the Amargosa drainage, testifies to a former connection of the waters of these basins. Local differentiation in each of the three genera suggests that the basins have been isolated since the Pleistocene. One of the most strongly marked of the isolates is described in this paper.

Cyprinodon salinus, new species

TYPES.—The holotype, a mature male 42 mm. long to caudal base, was collected by Robert R. Miller and Alex J. Calhoun in Salt Creek, Death Valley, Inyo County, California, on July 17, 1938; Cat. No. 132940, University of Michigan Museum of Zoology. The 2,175 paratypes comprise 1,642, 12 to 45 mm. long, taken with the holotype; 36 adults, Cat. No. 65962, collected by Joseph Grinnell (presumably on April 14, 1917); 9 small adults, Cat. No. 94444, taken by Paul Allen on January 25, 1932; and 488 young to adult specimens, Cat. No. 140482, seined by R. R., R. G., and F. H. Miller on September 29, 1942. In addition, 147 specimens catalogued as number 23045 in the Stanford University collections are designated as paratypes; they were collected from Salt Creek by Joseph Grinnell, April 14, 1917.

DIAGNOSIS.—A very slender *Cyprinodon*, with the dorsal fin much nearer the caudal base than the tip of the snout, with very small and much crowded

¹Waring (1920) does not state that the lake in Pahrump Valley overflowed into Ash Meadows (Amargosa River drainage) but this seems likely.

scales, and with a prominent ridge on the outer face of the tricuspid teeth. Also, most of the preorbital region is scaleless, a feature of *salinus* shared or closely approached by *C. diabolis* of the Amargosa basin² and by the Texan species *C. bovinus*, particularly the form described as *C. b. rubrofluviatilis*. That subspecies further resembles *salinus* in having a high predorsal scale count, and two West Indian species, *C. bondi* and *C. laciniatus*, otherwise very different, have almost as numerous lateral and transverse scales as the new species.

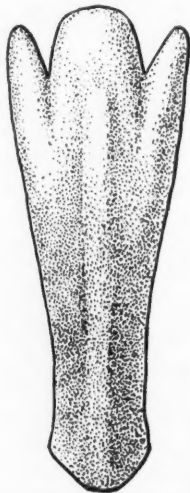


Fig. 1. Outer face of mandibular tooth from middle of lower jaw of female paratype, 32 mm. long, of *Cyprinodon salinus*. Length, 0.57 mm. Drawn by Grace Eager.

DESCRIPTION.—The form and coloration of this distinct species are shown in Plate I, the tooth characters in Figure 1, and the proportionate measurements in Table 1. The slenderness of the body may be further expressed by giving the ratios resulting from stepping (with fine dividers) the body depth into the standard length: males 2.5 to 3.0, usually 2.6 to 2.9 (ave., 2.73); females 2.9 to 3.4, usually 3.0 to 3.3 (ave., 3.14). These ratios were obtained from 80 specimens (40 of each sex), varying in standard length from 30 to 49 mm. The posterior position of the dorsal fin can be similarly expressed by projecting forward the distance between the caudal base and the dorsal origin and noting the point reached by the tip of the dividers. In 37 males, 27 to 46 mm. long, this point falls between the middle of the preopercle and the anterior margin of the pupil, usually between the posterior margin of the eye and the middle of the pupil. The point varies in 35 females, 29 to 50 mm. long, from about the middle of the opercle to the posterior margin of the eye, usually falling on or near the preopercle. The point is always behind

² *Cyprinodon diabolis* (Wales, 1930) is a well-marked species confined to Devil's Hole in Ash Meadows, Nye County, Nevada.

TABLE I
PROPORTIONAL MEASUREMENTS OF MATURE ADULTS OF *Cyprinodon salinus*¹

	Holo- type	Paratypes (U.M.M.Z., No. 132941)					
		Large Males		Large Females		Small Males	
		Range	Ave.	Range	Ave.	Range	Ave.
Standard length, mm.	42	39—45	42	36—48	40	26—28	27
Measurements in thousandths of the standard length							
Dorsal origin to tip of snout.....	593	584—618	598	587—615	601	561—583	573
Pelvic origin to tip of snout.....	547	545—560	551	550—564	558	530—561	550
Anal origin to caudal base.....	382	366—380	374	346—368	354	334—377	373
Body, greatest depth.....	383	362—398	377	315—346	326	330—338	333
Greatest width.....	219	219—233	225	218—236	228	215—228	220
Head, length.....	301	298—306	302	285—298	293	294—311	304
Depth.....	268	243—265	254	231—243	237	220—228	223
Width.....	223	220—231	226	216—234	225	213—222	216
Caudal peduncle, length.....	267	257—272	264	237—254	246	245—256	252
Least depth.....	191	176—192	186	156—174	162	157—173	164
Interorbital, least bony width.....	116	107—122	112	105—118	110	105—118	111
Preorbital, least width.....	56	51—57	54	47—54	50	42—48	45
Preorbital margin to preopercular angle.....	164	156—164	160	148—155	152	155—164	159
Eye margin to preopercular angle.....	125	115—125	119	102—113	108	96—107	103
Opercle, greatest width.....	91	88—97	92	88—99	93	102—107	104
Snout, length.....	103	100—109	105	96—105	100	92—99	95
Orbit, length.....	74	68—74	71	67—77	72	77—81	79
Mouth, width.....	117	106—120	114	111—123	117	108—118	113
Upper jaw, length.....	119	106—117	110	103—112	108	104—111	108
Mandible, length.....	101	96—102	99	93—104	97	96—100	98
Dorsal fin, basal length.....	194	182—194	187	161—177	169	184—192	188
Height.....	284	275—297	286	247—261	252	263—272	268
Anal fin, basal length.....	115	108—115	110	101—108	104	115—125	120
Height.....	217	207—224	217	193—210	202	238—259	250
Middle caudal rays, length.....	200	188—206	196	176—197	188	197—215	208
Pectoral, length of longest ray.....	195	186—203	193	170—184	177	182—193	189
Pelvic, length of longer fin.....	94	87—101	93	80—91	86	85—96	91
						76—87	81

¹ Ten large and 6 small of each sex were measured.

the anterior border of the eye in the males, and behind the pupil in the females. As in *Cyprinodon nevadensis* (see Miller, 1943: 6), the predorsal length divided by the prehumeral length (the distance between the posterior margin of the humeral process and the tip of the snout) gives a ratio of 1.7 to 1.9 (ave., 1.8) for both sexes.

The scales are small and crowded and many of the counts are higher than in any previously known species of the genus. The lateral scales number 27 to 34,³ almost always 28 to 31 (ave., 29.57); dorsal to pelvic (transverse scales), 12 to 16, usually 13 to 15 (ave., 14.48); dorsal to anal 11 to 15, usually 13 or 14 (ave., 13.37); predorsal 23 to 29, usually 24 to 28 (ave., 26.10); and around the caudal peduncle 17 to 22, usually 18 to 21 (ave., 19.72). Each of these series of counts is based on 100 specimens. The very high number of predorsal scales immediately distinguishes *salinus* from any other known kind of western *Cyprinodon*.

The detailed structure of the scales (Miller, 1943: 5, 7-8, Pls. VI and VII) is essentially the same as that described for the Amargosa species *Cyprinodon nevadensis*. The interspaces between the circuli are densely reticulate, particularly so distally, and upturned projections along the circuli (prominently displayed by *C. macularius*) are absent, except as they are occasionally feebly developed near the focus. In outline the scales are oval to nearly circular. They are deeper than broad but typically not as deep as in *nevadensis*. The focus lies at or very near the center. *C. salinus* is somewhat intermediate between *nevadensis* and *macularius* in the number of radii (15 to 22, usually about 18, on specimens varying from 31 to 48 mm. in length). The scale studied was the seventh in the mid-line posterior to the shoulder girdle.

The mandibular teeth (Fig. 1) of the new species are distinctive, although resembling those of *macularius* in some features and *nevadensis* in others (for comparison, see Miller, 1943: 8-9, Fig. 1). The principal feature is a prominent median ridge along the length of the outer face. It arises near the base of the central cusp as a rather low keel but rapidly increases in height and extent down the shaft. The ridge is stronger than the one recently described for *C. laciniatus* (Hubbs and Miller, 1942: 3, Fig. 1). The shaft is fairly broad at the terminal end but decreases gradually to the somewhat narrow base where it is very nearly one-half the width of the distal end. The slightly to moderately broad middle cusp is spatulate to bluntly pointed and slightly to distinctly longer than the rather pointed outer cusps. Distally it is not more than twice the width of the lateral cusps, commonly somewhat less. In certain features, particularly the size and shape of the median cusp, the teeth are quite similar to those of *C. diabolis*, but that species (as well as all others in the Death Valley System) lacks a ridge on the outer surface.

The preorbital region is virtually scaleless, a feature which provides an exception to the recent statement by Myers (1935: 302) that the squamation in this area always rises in front above the level of the lower part of the eye in the genus *Cyprinodon*. In *salinus* the region above the lower edge of the eye is naked about as frequently as it is scaled. When scales are present, they are generally very small and deeply embedded dorsally, sometimes iso-

³ This is a difficult count owing to the crowded nature of the scales. The last scale is often small and nearly hidden by the one preceding it.

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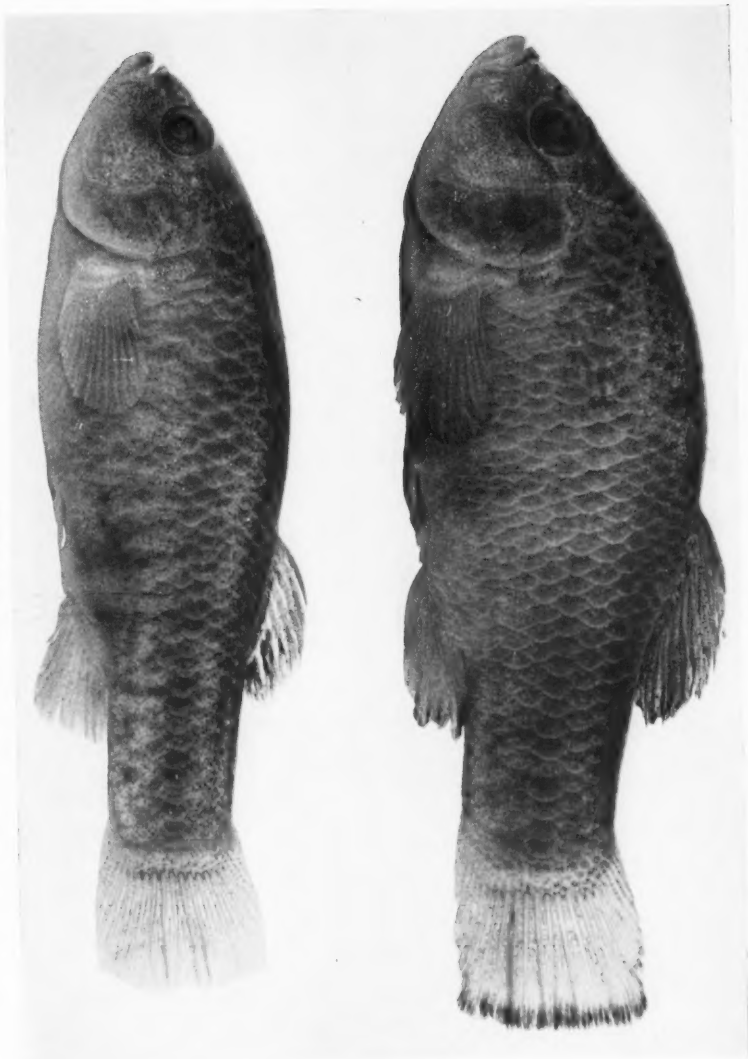
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Adult male holotype (above), 42 mm. in standard length, and female paratype, 40 mm. long, of *Cyprinodon salinus*.

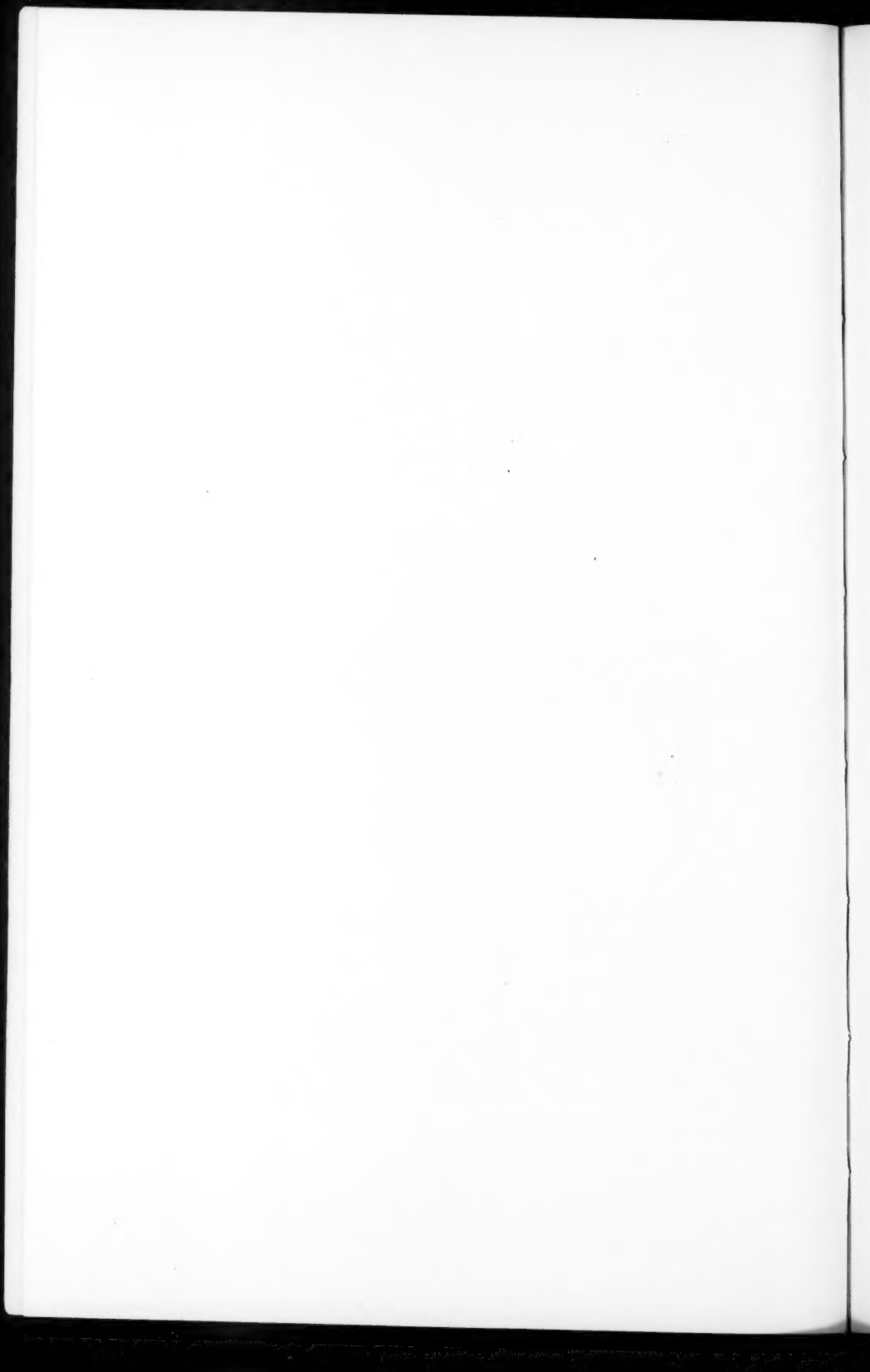
PLATE I



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PLATE I





lated, and restricted to a single, rather narrow row touching the front edge of the orbit. This leaves a scaleless strip anteriorly which is as wide as or wider than the scaled portion, and which continues downward and obliquely forward below the mouth. Even the area lying well below the orbital rim is not infrequently bare. In these extreme specimens the arrangement is almost identical to that described for *Floridichthys* (Myers, *loc. cit.*). However, the free edges of the scales are always directed upward as in *Cyprinodon*. In *C. diabolis* the lack of preorbital scales is even more pronounced than in *salinus*, for the scales on the cheeks never rise above the level of the lower part of the eye.

The average number of fin-rays is generally lower than in most species of *Cyprinodon*. The following data are based on counts of 100 specimens. Dorsal 8 to 11, almost invariably 9 or 10 (ave., 9.48); anal 7 to 11, usually 10 (ave., 9.95); pectoral (left fin) 14 to 17, commonly 15 or 16 (ave., 15.79); pelvics (both fins) 0 to 7, usually 6 (ave., 5.93); caudal 15 to 19, usually 16 or 17 (ave., 16.78). As in the closely related species *C. nevadensis*, the pelvic fins are small and tend toward reduction, but do not attain the extreme degeneration noted in that species (Miller, 1943: 9, 11, Table III). In the 100 specimens counted only one pelvic fin was missing, and in 560 additional fish (young to small adult, 12 to 29 mm. long) both fins were missing from only one specimen and one fin from two specimens, and the fins were abnormal (variously atrophied or markedly unequal in length) in 53 individuals; the remaining 504 had normally developed pelvics.

The lateral-line pores on the head are rather well developed. This is particularly true of those on the preopercle, which are noticeably larger than in the other western species (*diabolis* excepted). The preopercular pores vary from 13 (rarely) to 16 (uncommonly), and usually number 14 (ave., 14.44), and the lachrymal pores from 0 to 8 (both extremes rare; usual number 6; average 5.54). The average number of preopercular pores is higher than in *nevadensis* but is equalled by *diabolis* and exceeded by the Owens Valley form. The counts for both sides of the 50 specimens studied are added together. No accurate enumeration of the mandibular pores was obtained, but these appear to be degenerate as in the other species of the Death Valley System.

The gill-rakers number from 18 to 22, almost invariably 19 to 21 (average for 50 fish, 20.00), and are shorter, more toothed, more compressed and on the average more numerous than in the other species of the region. In these counts there is virtually no overlap with *diabolis*, in which the average is only 16.36. The high number in *salinus* is thought to reflect an adaptation to earlier lake conditions when Lake Manly was in existence. Good light and high magnification are required for an accurate count (which includes all rudiments), and a jet of compressed air is a considerable aid.

In still another feature the new species differs from its close relatives: the pectoral fins of the male are shorter and more rounded, and the length of this fin stepped into the standard length yields ratios varying from 5.0 to 5.6. In *nevadensis* these ratios are 4.0 to 5.0, usually 4.1 to 4.8 (over 4.8 in only one population); in both *diabolis* and the Owens Valley form, the ratios fall within the range for *nevadensis*.

VARIATION.—*Cyprinodon salinus* shows little variation in most of the characters studied. Table I will testify to the generally small range of variation in body proportions. The tooth characters are constant among medium and small sized individuals, but wear and injuries often obscure these features in the larger specimens. Most of the fin-ray counts and many of the scale counts exhibit very symmetrical distribution curves. This is likewise true of the gill-raker and preopercular pore counts. Long isolation and inbreeding are thought to be important factors in the comparatively small amount of variation exhibited by the new species.

As usual in the genus, the pattern of the cross-bars (particularly in the females) is variable. The inconsistent development of preorbital scales has already been discussed.

SEXUAL DIMORPHISM.—As usual in *Cyprinodon* the sexes differ markedly. The differences in depth of body have already been indicated and are well shown in Plate I. The body of the female is evenly slender throughout, whereas that of the male is noticeably arched before the dorsal fin. As in most species of *Cyprinodon*, the scales of the male develop moderately strong hair-like contact organs or ctenii, which are conspicuous during the breeding season (about April to September) but are apparent also in January. These ciliations are most prominent on the nape and sides of the head and also occur along the body, particularly between the dorsal and anal fins and on the sides of the caudal peduncle. This seems to be the usual pattern for the genus (Newman, 1907: 327).

The markings of the sexes are also quite different. On the sides of spawning males there are about 5 to 8 broad vertical bars which are either continuous or interrupted ventrally. They are as broad as or broader than the lighter interspaces dorsally, but are often narrower ventrally, though not as constricted as those of the female. Usually these bars are less conspicuous than in the female except during the spawning act, when their intensity is greatly heightened. In both sexes the bars tend to fade rather quickly after preservation, as is evident in Plate I. The dorsal fin is usually much blackened, and the pectorals, pelvics, and anal are black-bordered. The caudal has a faint to rather well developed terminal black band (well shown in Pl. I). The male is further distinguished from the female by the presence of a genital papilla and in having much larger dorsal, anal, and pectoral fins. Also, the head is deeper, the caudal peduncle longer and thicker, and the distances between the corner of the mouth (preorbital margin) and the angle of the preopercle and between the ventral margin of the eye and that angle are greater (Table I).

The females usually have about 4 to 8 principal, continuous vertical bars crossing the sides, which are wedge-shaped or squarish at the upper end and narrowly attenuate ventrally. They are much narrower than the lighter interspaces and are more commonly continuous posteriorly, although occasionally disrupted at both ends and continuous only medially. Not infrequently there are only one or two continuous bars, or even none at all. The reduction or loss of bars appears to be a tendency among old fish (in which the dorsal ocellus is also occasionally absent). Several narrower bars (usually discontinuous) and small spots or blotches are commonly interpolated between the

continuous bars, or the whole pattern is often much disrupted. As in most species of *Cyprinodon*, there is a weak to fairly well developed dark splotch, bar, or ocellus on the posterior rays of the dorsal fin. All the other fins are plain.

The life colors also distinguish the sexes. In breeding males the sides are bluish to turquoise, with bronze reflections, and deep, purplish-blue iridescence appears along the back and upper sides, particularly in the area between the dorsal fin and the occiput. This color varies to metallic bluish-green under different light conditions. The scales on the cheeks (especially over the opercle) exhibit bright blue reflections, whereas bluish-green and bronze reflects from the sides of the caudal peduncle. The broad cross-bars are deep bluish-grey. The outer rays of the anal and most of the pelvics show a metallic turquoise overcast in the brightest males.

The general color tone of the female is brownish, often with a lighter zone on each side just below the back (a similar zone is sometimes present in the males). The upper sides exhibit metallic greenish-blue to bronze reflections and below the mid-line the ground color is silvery to greyish-white. The silvery operculum gives off bluish and golden reflections. The cross-bars are brownish, usually darker above (often nearly black) and golden below. In both sexes the belly is white and there is a silvery sheen over the sides of the body (a feature characteristic of many marine fishes).

HABITAT.—Salt Creek, appropriately named in reference to its saline waters, rises from seepage flows in the southeastern arm of Mesquite Flat, about 6 miles east-southeast of Stovepipe Wells Hotel in the northern part of Death Valley. The seepages collect into a meandering, mud-bottomed channel, the upper portion of which is overhung by *Salicornia* and contains water throughout most of its length only during the winter and spring. About a mile and a half below its source, near the lower end of the Flat, the stream becomes permanent and abruptly enters a canyon or narrows, through which there is a marked channel flanked by alkali mud walls 10 to 20 feet high. This section of the creek, which harbors nearly the entire fish population, is not more than 2 miles in length. At its upper end steep bluffs rise on the east side nearly 200 feet above the level of the creek bed, and low clay hills occur on either side in the lower portion of the canyon. The bluffs and hills are virtually bare of any vegetation. At the end of the canyon Salt Creek disappears into the desert sands of the floor of Death Valley. A dry wash extends some distance farther and the valley slopes southward about 30 miles to Bad Water, 280 feet below sea level. This is also the sink of the Amargosa River which in extreme floods enters from the south.

Salt Creek lies entirely below sea level, varying in elevation from about -180 to -250 feet. At intervals the canyon contains rather deep pools which are densely overhung by great, springy mats of salt grass, *Distichlis spicata*, and growths of pickleweed or iodine bush, *Allenrolfea occidentalis*, are commonly interspersed. The salt bush, *Atriplex linearis*, also occurs along the channels and the turtle back, *Psathyrotes ramosissima*, is present on the slopes of the wash. In the summer of 1939, *Ceratophyllum demersum* covered large portions of several of the pools near the head of the canyon, and provided the fish with shelter, food, and suitable spawning places.

The larger pools in the canyon reach a width of 30 feet and a length of nearly 75 feet. The depth of water varies from about 1 foot to over 5 feet. The pool bottoms are of thick mud, into which the fish frequently burrow when alarmed; the overhanging mats of salt grass also provide effective refuge areas. The current is generally slight in the pools and moderate in the interconnecting channels, which are commonly roofed over by the salt grass. At 10 A.M. on July 17, 1938, the water temperature at a depth of 2 feet was 81.4° F. and the air 105.8°. In the shallow side sloughs, temperatures were as high as 100°, but young fish only were present in such high-temperature habitats. In winter the water temperature drops to at least 50°, and in severe seasons probably very nearly reaches freezing.

An analysis of the water from Salt Creek has been made by the Rubidoux Laboratory of the United States Department of Agriculture at Riverside, California. I am much indebted to Mr. C. S. Scofield, Principal Agriculturist, who has kindly consented to the publication of this analysis (No. 6044), made on April 21, 1932. The results are as follows: pH, 8.6; $K \times 10^5$ at 25° C., 3368; total solids, 23,594 p.p.m.; boron, 38.8 p.p.m.; As_2O_3 , 0.4 p.p.m.; silica, 29 p.p.m.; Ca, 5.68; Mg, 30.39; Na, 341.45; K, 12.83; CO_3HCO_3 , 12.85 (including 4.00 of normal carbonate); Cl, 290.50; SO_4 , 77.28; and NO_3 , 0. The last eight items are in milligram equivalents per liter. The sample was taken at the road crossing southwest of McClean Spring, near the northeast corner of T. 16S., R. 45E., at 210 feet below sea level. The temperature was 17.5° C., and the discharge 0.5 c.f.s. The high values for total solids, boron, and the various salts are noteworthy. Roughly speaking, the concentration is about four-fifths that of sea water.

RANGE AND ABUNDANCE.—*Cyprinodon salinus* is known only from Salt Creek. In June and July, 1938, the fish were found to occur from about 100 yards below the old bridge nearest McClean Spring (nearly 100 yards above the low falls which mark the beginning of the canyon proper) to nearly the end of the canyon. They were swarming in every pool and channel examined and were so abundant that only two hauls of a six-foot seine were required to net the collection of 1,643 young to adult. This was but an insignificant portion of the total population which was then conservatively estimated as amounting to many millions. However, as air temperatures rise to 120 degrees or more during the summer, many thousands of fish are left stranded in side pockets and sloughs and perish as the waters of the stream shrink toward minimum flow of the fall. In the smaller pools, desiccation is often accompanied by stagnation which, accentuated by overcrowding, often leads to conditions so severe that emaciation or even local extirpation occurs. Other natural enemies contribute to the great reduction which takes place between summer and winter. Among these are the larva and adult of the water scavenger beetle, *Hydrous triangularis*, and various aquatic birds (the great blue heron in particular), raven, and other predators. According to Tom Wilson, a local Indian, the Panamint Indians formerly utilized the species for food by gathering quantities of the fish in large porous baskets, aided by "tule" brooms. The contents were then baked, with the fish lying between layers of tule reeds and these alternating with layers of hot ashes. This practice has apparently been discontinued for two or more generations.

RELATIONSHIPS.—In the fundamental feature of scale structure, *Cyprinodon salinus* agrees with all of the species of *Cyprinodon* in the Death Valley System (Miller, 1943). Many of the other characters described for the new species are shared by *C. nevadensis*, the only other species known from Death Valley. These resemblances include the small pelvic fins (tending toward reduction or loss), the posterior position of the dorsal fin, the short head and small eye, the low average number of fin-rays, and the rather inconspicuous humeral process.

Cyprinodon salinus differs considerably from the large-scaled, dwarfed species *C. diabolis*. Wales (1930:70) stated that in males of the Salt Creek form the anal fin closely resembled that of *diabolis*, as in both species its length is equal to the distance from the posterior edge of the opercle to between the eye and tip of the snout. However, this comparison fails to consider that in *diabolis* the head parts are relatively long while in *salinus* they are short. Consequently, when the length of the anal fin is stepped into a common denominator (the standard length), the results show that this fin is much longer in *diabolis*. The ratios are: 3.0 to 3.5 for *diabolis*, and 4.0 to 4.5 for *salinus*. In the shorter anal, the new species again resembles *nevadensis*.

Cyprinodon salinus was evidently derived from the stock which gave rise to *nevadensis*. During the existence of Lake Manly this ancestral form was probably rather widely distributed, but as the lake disappeared part of the stock became isolated in Salt Creek. It seems likely that this population did not intermingle again with those in the Amargosa basin, as the considerable amount of differentiation exhibited by *salinus* suggests a long period of isolation. Furthermore it seems unlikely that even a *Cyprinodon* could traverse the sump of Bad Water. What effect the rather extreme environment has had upon the evolution of the new species is problematical. The nearest population of *nevadensis* occurs in the Amargosa River in the southern end of Death Valley, about 75 miles southeast of Salt Creek. The habitat here is very similar to that at Salt Creek; but, with the exception of reduced squamation in the preorbital region, this population does not show the distinctive characters attributed to *salinus* (for comparison, see Miller, 1943: Pl. 3, Figs. 1 and 2). The Salt Creek species may be considered as a specialized derivative or relict form of the late Pleistocene ancestor which populated Lake Manly.

SYNONYMY.—In his account of the cyprinodonts of the Death Valley region, Wales (1930: 70) identified the Salt Creek population with *Cyprinodon macularius*. Until very recently, this classification has been followed in the information booklet distributed by the National Park Service (Anonymous, 1935), but the 1941 edition (following information received from the writer) identifies the fish to genus only, pointing out that the populations in Salt Creek and Saratoga Springs represent different species.

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The Theoretical Relationship Between Fishing Effort and Mortality

By MILNER B. SCHAEFER

THE problems involved in measuring the rate of exploitation of a fishery have received considerable attention from biologists in recent years. The theoretical relationships between the amount of fishing and the resulting effects on the stock have been dealt with by several authors. Most recently Ricker (1940) has approached the problem by setting up for analysis two extreme types of fisheries: Type I in which natural mortality and recruitment are negligible during the fishing season; and type II where natural mortality, recruitment and fishing mortality occur at a uniform rate.

For the type II fishery the following definitions and notations have been given by Ricker, and are employed here for the sake of uniformity of terminology.

mortality rate = the annual expectation of death of fish of catchable size from a given cause, *if no other causes of death were operative.*

n = natural mortality rate, or expectation of death from natural causes, *if no other causes were operative.*

m = fishing mortality rate, or expectation of death from fishing, *if no other causes were operative.*

$a = m + n - mn$ = total mortality rate from both causes.

$\mu = \frac{m}{m + n} (m + n - mn)$ = the expectation of death by capture, taking other causes into account. This is also the fraction of the stock caught, or the rate of exploitation.

f = number of units of gear fished, or fishing effort.

It may be seen that in a type I fishery, which may be regarded as a special case of a type II fishery in which $n = 0$, that $m = a = \mu$. In other words, in a type I fishery, the mortality from fishing is also the total mortality, and is also the rate of exploitation.

By a careful analytical investigation, Ricker has shown that for a type I fishery, the relationship between fishing effort and fishing mortality in two different years may be expressed by

$$\frac{f_2}{f_1} = \frac{\log (1 - m_2)}{\log (1 - m_1)} \dots\dots\dots (1)$$

For a type II fishery he suggests that the relationship may be *approximated* by

$$\frac{f_2}{f_1} = \frac{\log (1 - \mu_2)}{\log (1 - \mu_1)} \dots\dots\dots (2)$$

The approximation (2) is based, apparently, upon certain loose numerical computations, during the course of which logical errors were made when simplifying assumptions were introduced, thus nullifying the results.

It is the purpose of this paper to show that, by an analytical process analogous to that given by Ricker for a type I fishery, we may arrive at

the relationship between gear fished and mortality produced in a type II fishery. Furthermore, it is of the same form as that for a type I fishery, *but the difference in the nature of "m" in the two cases must be kept in mind.*

Following Ricker's notation, as far as practicable:

let p = the population at the start of the season.

b = the total deaths from *all* causes up to time t .

a = the fraction of p dead up to time t , from all causes.

m = the fraction of p which would die up to time t if fishing were the only cause of death.

n = the fraction of p which would die up to time t if natural mortality were the only cause of death.

a_1, m_1, n_1 = the corresponding mortalities up to the end of the season.

These are the same "annual rates" as those defined near the beginning of this paper without the use of subscripts.

We may postulate:

1. The rate of decrease of the population as a result of fishing mortality will be proportional, at any instant, to (1) the number of survivors at that instant and (2) the amount of gear in use.

2. The rate of decrease of the population as a result of natural mortality will be proportional, at any instant, to the number of survivors at that instant.

These postulates may be formulated as follows:

$$\frac{d(p-b)}{dt} = -k_1 f(p-b) - k_2(p-b) \dots\dots\dots (3)$$

where k_1 and k_2 are proportionality factors.

Since p is constant $\frac{dp}{dt} = 0$, and therefore,

$$\frac{db}{dt} = k_1 f(p-b) + k_2(p-b)$$

But, by definition, $a = \frac{b}{p}$

$$\text{hence, } \frac{db}{dt} = p \frac{da}{dt}$$

$$\text{Thus, } p \frac{da}{dt} = (k_1 f + k_2)(p - ap)$$

And, since $p \neq 0$,

$$\frac{da}{dt} = (k_1 f + k_2)(1 - a)$$

$$\frac{da}{1-a} = (k_1 f + k_2) dt$$

$$\text{Then, } \int_0^{a_1} \frac{da}{1-a} = \int_0^1 (k_1 f + k_2) dt \dots\dots\dots (4)$$

$$\text{leading to, } \log (1 - a_1) = - (k_1 f + k_2) \dots\dots\dots (5)$$

Since (5) is true for all values of a less than 1, we may evaluate k_2 by considering the case where $a = n$, (when $f = 0$), and

$$\log (1 - n_1) = - k_2 \dots\dots\dots (6)$$

Now, since $a_1 = m_1 + n_1 - m_1 n_1$

$$\log (1 - a_1) = \log (1 - m_1) + \log (1 - n_1) \dots\dots\dots (7)$$

Hence, from (5), (6), and (7)

$$\log (1 - m_1) = - k_1 f \dots\dots\dots (8)$$

This leads immediately, considering two different years, to

$$\frac{f_2}{f_1} = \frac{\log (1 - m_2)}{\log (1 - m_1)} \dots\dots\dots (9)$$

Q. E. D.

It may be seen from the above analysis that the type I fishery may be regarded most simply as a special case of the type II fishery. When n is taken to be zero, the equations immediately reduce to those given by Ricker for a type I fishery.

The factor of recruitment has not been taken into account in the above analysis. If recruitment occurs at a uniform rate throughout the season, that is if it is proportional at any instant to the population at that instant, the same solution as that found above (9) is obtained, since this additional postulate merely adds to (3) a term of the form

$$+ k_3 (p - b)$$

where, now, b will represent the excess of deaths from all causes over recruitments up to time t . The resulting equation has the same solution (9) for the relationship between f and m .

The problem is much more complex when the mortality or recruitment rates are not uniform, and leads, in general, to no simple solution.

Finally, it should be observed that this relationship between fishing effort and mortality produced is not original here. It is the same relationship proposed by Baranov (1918), although derived in a different manner, and by Thompson and Bell (1934).

It is hoped that this paper will serve to clarify the problem involved, and to bring together the notation employed by Ricker with the fundamental solution originally arrived at several years earlier by the authors cited above.

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A Note on Erratic Viciousness in *Astyanax mexicanus* (Phillipi)

By C. M. BREDER, JR.

INCIDENT to studies on the genetics of the blind cave characin, *Anoptichthys jordani* Hubbs and Innes, the development of a stock of *Astyanax mexicanus* (Phillipi) was undertaken in the Department of Animal Behavior at the American Museum of Natural History. These fishes reproduced in the generalized characin manner with the great egg eating proclivity on the part of the parents and the very occasional tendency for a single fish to be picked on by its tank mates, usually culminating in the destruction of the latter. When this occurred the only evident superficial damage was that the tail-fin had been reduced by about one-half but removal of the injured fish to another tank failed to prevent its subsequent demise. In most other kinds of aquarium fishes an injury of this extent would be merely a passing incident, with a rapid regrowth of the fin, unless infection developed. In the present case there was no evidence of infection in any specimen. Such picking took place most often, when for one reason or another, feeding had been skipped for a day. With mated pairs it occurred only where one happened to be much smaller than the other and then rarely. This refers to normal, eyed river fish. With blind fish or those with defective vision, destruction by normal eyed fish was common and is apparently rooted in the difference in the social behavior of the blind and the seeing, a feature discussed by Breder and Gresser (1941a and b). The present item is in no way connected with this matter of differential behavior.

Normally, these river fish remain in a compact aggregation at some favored part of the tank and unless disturbed by food or other environmental items form a fairly well organized quiet rest school. On an adequate stimulus a very good fright school is formed with each fish acting as a similar unit in regard to direction of orientation, distance from its fellows and similar features, characteristic of the fish school in the restricted sense. The incident in question took place in an aquarium measuring 2 feet by 1 by 1 which contained eighteen specimens of from 34 to 50 mm. in standard length. These

were the product of a single spawning of a pair of fish which was brought from the Rio Tampaon, at Pujhal, San Luis Potosi, Mexico, in 1940. The eggs had been hatched in another aquarium on May 11, 1942, and the young were transferred to this aquarium on July 16. This school of fish grew and fed voraciously, showing full vigor until November 1. On routine examination of the aquaria it was found on the morning of the next day that most of the fish were dead and about half a dozen, still alive, were huddled in a tight school and very evidently in serious difficulty, showing their darkest phase. Later that day they too expired. On examination, each fish was seen to have its tail-fin at least half gone. There was nothing else present in the aquarium except sand, aquatic plants and an aeration tube. Six other aquaria containing sibs of these, in greater or less numbers, were all in perfect order as all of them had been for months.

Whatever happened in this aquarium is not entirely clear but it evidently triggered off something in the nature of "a free for all" in which not a single fish triumphed or survived. There was no question of lack of food as they had been fed each day, including the morning of November 1. Although I have had a considerable experience with a wide variety of fishes in captivity no such sudden or complete self-destruction had ever been previously experienced.

There had been no evidence of earlier predation in these or other aquaria but in measuring these fish a curious item in the distribution of the sizes became apparent. The measurements in standard length to the nearest millimeter showed the following distribution in classes of 2 mm.

Classes	No. of individuals
34-35	6
36-37	3
38-39	2
40-41	2
42-43	2
44-45	2
46-47	0
48-49	0
50-51	1

This distribution of variates has the appearance of the upper limb of a normal frequency curve and it suggests that all specimens which had failed to reach a certain size early in life may have been destroyed by their fellows. Thus, those that were incapable of reaching 34 mm. in 173 days were presumably used as food by the others. That this must have happened when they were still in the fry stage is evident since there were clearly no losses after the fish had reached a sufficient size to be readily seen in the aquarium.

Any attempt to understand this peculiar performance naturally calls to mind the famed piranhas and their extreme vigor in attack, which is apparently usually instigated by the letting of blood. Occasionally species of this sub-family may attack one another in aquaria, but in all cases known to the author, at least one fish survived, making it clearly master of the situation.

That a somewhat piranha-like disposition is present in the genus *Astyanax* can be personally attested to in *Astyanax ruberrimus* Eigenmann. Regarding this species, Breder (1927) wrote:

These fish are uncommonly fearless, swarming about any commotion in or near the water. They made bathing a rather exciting sport, closing in, often by the hundreds, and snapping at one with their sharp teeth. While, of course, unable to do any damage, indeed rarely drawing blood, their teeth were sufficient to give the sensation of a sharp pin prick. Their method was not to nibble, but to grasp a small amount of skin and hang on, vigorously shaking in "bulldog fashion." Only violent movements would keep them off and then on the slightest cessation of this effort they would close in again. At our base camp on the Rio Sucubti a slight rise in the level of the water caused a small inlet to form under one side of the mess table. Here they would savagely tear apart any crumbs that might be tossed their way. Strangely enough, though suffering such proximity, they were most difficult to catch with a dip net, so great was their maneuvering ability. They sensed danger rapidly and could be quickly frightened away with a dip net. In less than half an hour they would return and the performance could be repeated with a few caught each time. Their ferocity was such that even a slightly injured member of a school was at once torn apart to form food for the rest. As a result, even in the present large series none showing any wounds are to be found and it is doubtful if any in a school ever survive more than the slightest injury. This was made the object of experiment on several occasions and always with the same outcome. They appear to be imbued with the same spirit that pervades the large and evil-famed *Serrasalmo* of farther south.

The above observations made in 1924 in Panama were decidedly different from those made in 1940 in Mexico on *Astyanax mexicanus*. In the Rio Tampaon these fishes behaved like any normal minnow and in aquaria showed no extraordinary viciousness. The tendency to destroy blind individuals is evidently associated with the failure of the latter to show social behavior suitable for the eyed forms and is an entirely different matter. The outbreak herein described would seem to indicate an underlying vigor in attacking that can be brought out on appropriate stimulus. It suggests a considerable spread of the piranha behavior pattern in this regard in the genus *Astyanax* as well as indicating a basic similarity, apparently varying more in quantity than in quality.

Gregory and Conrad (1938) derive the Serrasalmoninae from the Cheirodontinae, as do numerous earlier students. This could be used to argue that the conditions herein discussed for *Astyanax* represent certain more or less primitive characteristics of behavior in the Cheirodontinae, which have been extended and emphasized in many of the more specialized Serrasalmoninae. A study of the details of the feeding and fighting behavior of representatives of both sub-families closest to the line of descent should go far to illuminate the development of the extremely voracious behavior marking the Serrasalmoninae.

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An Analysis of the Distribution of Fishes in the Streams of Western Massachusetts

By BRITTON C. McCABE

DURING the summer of 1940 the author, assisted by Paul Belkin, made 400 collections of fishes from the streams of western Massachusetts, an area including the watersheds of the Connecticut, Hoosic, and Housatonic rivers. In attempting to explain the distribution of these fishes, historical and ecological factors are considered in relation to the habits and habitat preferences of the various species.

Prior to 1940, no distribution study had been made, although four lists of fishes were published, as follows: In 1839, David Humphrey Storer published, as a state report, a list of the fishes of Massachusetts. Later, between the years 1853 and 1867, he revised, extended, and fully illustrated this report under the title, "A History of the Fishes of Massachusetts." Eighteen species or subspecies of fresh-water fishes were listed. Previous to Storer's report, Jerome Van Crowningshield Smith published in 1833 a "Natural History of the Fishes of Massachusetts" and also "A Catalogue of the Marine Fishes taken on the Atlantic Coast of Massachusetts." He recorded 17 fresh-water forms. This work was severely criticised by both Storer (1839: 347-356) and Gill (1904: 327) for its inaccuracies. In 1879, George B. Goode and Tarleton H. Bean, in a report on the "Fishes of Essex County," recorded 20 fresh-water forms. William C. Kendall (1908: 1-152) enumerated 35 species or subspecies for the state that live part or all of their lives in fresh water and 13 of these were from western Massachusetts.

The study just completed lists 46 species or subspecies of fishes, inclusive of anadromous and catadromous forms (see Table I). Of this number, 12 are classified as introduced and 34 as native, inclusive of the 5 sea-run forms.

Contrasting ecological conditions exist between the western and eastern drainage systems of the Connecticut watershed. The Deerfield and Westfield river systems, of the western Connecticut drainage, are influenced by the high, rugged Berkshire Hills in which many of their tributaries rise. As a result, the streams are usually fast-flowing over stream beds of gravel, rubble, and boulders. The Millers and Chicopee river systems, of the eastern Connecticut drainage, rising from ponds and swamps of the relatively low, broad Worcester plateau, tend to be slow-flowing, over stream beds predominantly formed of sand and mud. The smaller tributary streams of the Connecticut, that have their origin in the foothills of the Berkshires and the Worcester plateau, reflect in miniature the typical flow and stream bed of the Connecticut River itself, as it meanders through its flood plain from north to south in Massachusetts. The Housatonic and Hoosic river valleys, bordered on the east by the Berkshire Hills and on the west by the Taconic Range, portray all of the varied conditions of the Connecticut River valley.

Native stream fishes in western Massachusetts may be classified into four distributional groups: (1) Fishes of general distribution, abundantly represented in all of the drainage systems; (2) fishes of general distribution sparsely represented in all of the drainage systems; (3) fishes of restricted

distribution, abundantly represented in a few drainage systems; (4) fishes of restricted distribution, sparsely represented in a few drainage systems.

TABLE I
FISHES IN THE STREAMS OF WESTERN MASSACHUSETTS

Species ¹	Drainage Systems ²						
	D.	W.	N.C.	C.	Ho.	H.	S.C.
† <i>Petromyzon marinus</i>		S					S
† <i>Acipenser sturio oxyrhynchus</i>							S
† <i>Alosa sapidissima</i>							R
† <i>Salmo s. salar</i>							S
* <i>Salmo trutta fario</i>	S	S	S	S	S	S	S
* <i>Salmo gairdnerii irideus</i>	S	S			S	S	S
† <i>Salvelinus f. fontinalis</i>	S	S	S	S	S	S	S
† <i>Catostomus c. commersonnii</i>	S	S	S	S	S	S	S
† <i>Catostomus c. catostomus</i>							S
† <i>Catostomus catostomus nannomyzon</i>	S				S	S	S
† <i>Erimyzon o. oblongus</i>			S	S		S	S
* <i>Cyprinus carpio</i>							S
* <i>Carassius auratus</i>							S
† <i>Leucosomus corporalis</i>	S	S	S	S	S	S	S
† <i>Semotilus a. atromaculatus</i>	S	S	S	S	S	S	S
† <i>Couesius p. plumbeus</i>		S					S
† <i>Rhinichthys a. atratulus</i>	S	S	S	S	S	S	S
† <i>Rhinichthys cataractae</i>	S	S	S	S	S	S	S
† <i>Chrosomus eos</i>	S						S
† <i>Notemigonus c. crysoleucas</i>	S	S	S	S	S	S	S
† <i>Notropis c. cornutus</i>	S	S	S	S	S	S	S
† <i>Notropis hudsonius amarus</i>	S	S		S			S
† <i>Notropis bifrenatus</i>		S		S		S	S
* <i>Ameiurus m. melas</i>				S			S
† <i>Ameiurus n. nebulosus</i>	S	S	S	S		S	S
* <i>Ameiurus n. natalis</i>				S			S
† <i>Esox americanus</i>		S				S	S
† <i>Esox niger</i>	S	S	S	S	S	S	S
* <i>Esox lucius</i>							S
† <i>Anguilla bostoniensis</i>		S		S			S
† <i>Fundulus d. diaphanus</i>	S	S		S			S
† <i>Percopsis omiscomaycus</i>						S	
† <i>Morone americana</i>							S
† <i>Perca flavescens</i>	S	S	S	S	S	S	S
† <i>Stizostedion v. vitreum</i>							S
† <i>Boleosoma nigrum olmstedii</i>	S	S	S	S			S
* <i>Micropterus d. dolomieu</i>	S	S	S	S		S	S
* <i>Huro salmoides</i>				S	S	S	S
† <i>Lepomis gibbosus</i>	S	S	S	S	S	S	S
† <i>Lepomis auritus</i>		S		S		S	
* <i>Lepomis m. macrochirus</i>				S	S	S	S
† <i>Emmeacanthus obesus</i>		S					
* <i>Ambloplites r. rupestris</i>		S			S	S	S
* <i>Pomoxis nigro-maculatus</i>	S		S				S
† <i>Cottus cognatus</i>	S	S		S	S	S	
† <i>Lota lota maculosa</i>							R

¹ †—Native species. *—Introduced species. S—Specimen examined. R—Museum or literature record.

² Drainage Systems: D—Deerfield River System; W—Westfield River System; N.C.—Northern Connecticut and its tributaries north of Turners Falls; C—Chicopee River System; Ho.—Hoosic River System; H—Housatonic River System; S. C.—Southern Connecticut and its tributaries (exclusive of systems mentioned) south of Turners Falls.

(1) Fishes of general distribution, abundantly represented in all of the drainage systems, arranged in order of their frequency are: *Rhinichthys a. atratulus*, 272 collections; *Catostomus c. commersonnii*, 233 collections; *Notropis c. cornutus*, 191 collections; *Salvelinus f. fontinalis*, 137 collections; *Rhinichthys cataractae*, 102 collections; and *Esox niger*, 59 collections. The wide-spread occurrence of these fishes indicates a tolerance to varying ecological conditions, as previously noted for the drainage systems of western Massachusetts. The high rank of *Salvelinus f. fontinalis* is no doubt largely influenced by the intensive stocking policies of the Division of Fisheries and Game.

(2) Fishes of general distribution, sparsely represented in all of the drainage systems, arranged in order of their frequency are: *Lepomis gibbosus*, 54 collections; *Notemigonus c. crysoleucas*, 51 collections; *Perca flavescens*, 50 collections; and *Ameiurus n. nebulosus*, 23 collections. All of these species are recognized as "pond" fishes and this probably explains their paucity in the streams of western Massachusetts.

(3) Fishes of restricted distribution, abundantly represented in a few drainage systems, arranged in order of their frequency are: *Leucosomus corporalis*, 155 collections; *Boleosoma nigrum olmstedii*, 90 collections; *Semotilus a. atromaculatus*, 74 collections; and *Cottus cognatus*, 67 collections.

Leucosomus corporalis, one of the most common fishes in western Massachusetts, ranking fourth in frequency, is largely restricted to the eastern Connecticut drainage. *Semotilus a. atromaculatus*, with a ranking of eighth in frequency, is largely restricted to the western Connecticut drainage. The complementary distributions of these two fishes appears to be controlled by ecological factors. The area west of the Connecticut is generally mountainous, possessing an abundance of small streams with cool, clear water and therefore well suited to the creek chub. The land east of the Connecticut is relatively low, possessing streams that are predominantly of a slow-flowing, warm-water type, congenial to the fallfish.

Boleosoma nigrum olmstedii is represented in 90 collections, of which 62 are east of the Connecticut and the remainder in the middle and lower portions of the western tributaries. The absence of this fish from the upper reaches of the Deerfield and Westfield drainages is probably associated with its habitat requirements. The author believes the absence of this fish from the Housatonic and Hoosic drainages is due to its dispersion after the post-glacial flood waters had receded and these two drainages were no longer joined with the Connecticut.

Cottus cognatus is represented in 67 collections, of which 58 are west of the Connecticut. Its limited distribution east of the Connecticut appears to be influenced by the lack of suitable habitat conditions, for it favors streams having colorless, cool, moderately fast-flowing water, in which the plant material is scarce, and a stream bed that is mostly gravel, rubble, and boulders.

(4) Fishes of restricted distribution, sparsely represented in a few drainage systems, arranged in order of their frequency are: *Notropis bifrenatus*, *Catostomus catostomus nannomyzon*, *Erimyzon o. oblongus*, *Notropis hudsonius amarus*, *Esox americanus*, *Fundulus d. diaphanus*, *Lepomis auritus*,

Couesius p. plumbeus, *Catostomus c. catostomus*, *Chrosomus eos*, *Enneacanthus obesus*, *Stizostedion v. vitreum*, *Percopsis omiscomaycus*, *Morone americana*, *Lota lota maculosa*. Only the first three appear in enough collections to warrant any comment upon their distribution.

Notropis bifrenatus is represented in 26 collections, all of which are located in the southern half of western Massachusetts. Although its geographical range in this region of the state is broad, extending from the eastern to the western boundaries of the area surveyed, its ecological tolerance limits it to streams of the lowlands that have colorless, warm, moderately to slowly flowing water, in which the growth of plant material is from moderate to abundant and the stream bed is predominantly mud, gravel, and sand.

Catostomus catostomus nannomyzon was found at 17 stations, all of which are located in or west of the Connecticut, 13 being representative of the Hoosic and Deerfield drainages. *Erimyzon o. oblongus* was obtained in 14 collections, of which 11 are from the eastern drainage system of the Connecticut. These two fishes represent contrasting ecological requirements in western Massachusetts. The Adirondacks fine-scaled sucker appears to have relatively narrow confines of ecological tolerance which limits it to clear, cold, moderately fast-flowing streams which have sparse vegetation and stream bed materials that are predominantly gravel, rubble, and boulders. The chub sucker is restricted to warm, slowly-moving streams, having abundant vegetation and stream bed materials of sand, gravel, and rubble.

TABLE II

NATIVE FRESH WATER FISHES OF PROBABLE EARLY POSTGLACIAL DISTRIBUTION

Species	1	2	3	4	5 ¹
<i>Salvelinus f. fontinalis</i>	*	*	*	*	*
<i>Catostomus c. commersonnii</i>	*	*	*	*	*
<i>Leucosomus corporalis</i>	*	*	*	*	*
<i>Semotilus a. atromaculatus</i>	*	*	*	*	*
<i>Rhinichthys a. atratulus</i>	*	*	*	*	*
<i>Rhinichthys cataractae</i>	*	*	*	*	*
<i>Notemigonus c. crysoleucas</i>	*	*	*	*	*
<i>Notropis c. cornutus</i>	*	*	*	*	*
<i>Ameiurus n. nebulosus</i>	*	*	*	*	*
<i>Esox niger</i>	*	*	*	*	*
<i>Perca flavescens</i>	*	*	*	*	*
<i>Lepomis gibbosus</i>	*	*	*	*	*
<i>Cottus cognatus</i>	*	*	*	*	*

¹ 1. Above Salmon Falls on the Westfield River; 2. Above Salmon Falls on the Deerfield River; 3. Above Turners Falls on the Connecticut River; 4. The Housatonic drainage in Massachusetts; 5. The Hoosic drainage in Massachusetts.

The factors chiefly associated with the distribution of fishes in the streams of western Massachusetts may be divided into two groups: first, those controlled by man; second, natural factors. The first group includes stocking policies, pollution, and dams. These are of relatively recent origin and will not be discussed here. The second group is of ancient origin and includes phases of ecological associations, waterfalls, and glaciation. The influence of

ecological factors has already been noted. Glaciation and waterfalls are related and therefore may be summarized at the same time.

Early glacial waters, derived from the melting of the glacier that covered Massachusetts along with other New England states, formed a network of waterways that connected what are now isolated portions of the Connecticut watershed. Considering the extent of the glacial flood waters, the present distribution of fishes, and the location of waterfalls or other barriers above which only glacial waters had access, the author believes that the native fishes found above all such barriers depended upon glacial flood waters as a means of entry. The locations of such barriers are as follows: Salmon Falls on the Deerfield River at Shelburne Falls; Salmon Falls on the Westfield River at Woronoco; Turners Falls on the Connecticut River; falls on the Housatonic at Gaylordsville and Falls Village, Connecticut; falls on the Hoosic River at Schaghticoke, New York; and the low divide forming the watershed between the Housatonic River and the Hoosic River in northwestern Massachusetts. There are 13 species of native fishes found above all of these barriers (see Table II) which indicates a dispersion during early postglacial times before these areas were isolated by the recession of postglacial flood waters.

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The Reproductive System of the Brown Trout (*Salmo fario*)¹

By J. B. PARKER

THE results of the author's investigation of the reproductive system of the yellow perch (COPEIA, No. 4, 1942, December 28), together with results obtained in similar investigations of other teleosts now under way, were so greatly at variance with the description given in Parker and Haswell's *Zoology* of the reproductive system of the brown trout, in which the brown trout is used as a type of the teleost, that a reexamination of the reproductive system of this species seemed to be imperative. Accordingly the author obtained from the Fish and Wildlife Service a number of mature brown trout taken in the midst of the spawning season. Careful investigation of this material based on gross dissections and series of microtome sections has given the following results.

In the female the paired ovaries are devoid of peritoneum on their ventral aspect and the ripe eggs, which are smooth and relatively large, are discharged into the coelomic cavity. The evidence indicates that all ripe eggs are liberated at the same time or at least before oviposition begins. As a result the coelomic cavity is so completely filled that the ovaries, greatly reduced in size, are crowded far forward against the liver alongside the stomach. At the posterior end, on the ventral side, of the coelomic cavity there is an opening leading into an oviduct, of which the lumen is continuous with the coelomic cavity and of which the inner surface is covered with ciliated epithelium, as is the surface of the walls bounding the coelomic cavity. This oviduct opens to the outside through a distinct orifice (Fig. 1, o) on the urino-genital papilla, which lies posterior to the anus (Fig. 1, a).

The urinary duct lies posterior to the oviduct and is parallel with it. This duct opens to the outside through a separate and distinct orifice (Fig. 1, u) on the urino-genital papilla.

In the male the testes, one on either side the midline, are suspended by delicate membranes from the ventral surface of the swim bladder. They extend from the anterior end of the coelomic cavity backward about two-thirds its length. From the posterior end of each testis a glandular duct extends backward to join its fellow beneath the urinary bladder at the posterior end of the coelomic cavity. Here the two ducts combine to form a single, much enlarged, non-glandular duct that probably serves as a seminal vesicle. Beyond this enlargement the duct narrows and descends as a sperm duct to open to the outside through a distinct orifice (Fig. 2, s) on the urino-genital papilla lying behind the anus (Fig. 2, a).

As in the female, the urinary duct lies posterior to the genital duct and parallel with it and opens to the outside through a separate and distinct orifice on the urino-genital papilla (Fig. 2, u).

There is, therefore, no urino-genital sinus in the mature brown trout and

¹A contribution from the Biological Laboratory of the Catholic University of America, Washington, D. C.

there is no connection whatever between the urinary and genital systems in either male or female. One wonders how this error ever found its way into Parker and Haswell's *Zoology* in the first place, and one wonders still more how this text, so universally used, could go through so many editions and at least one revision without this error being detected. The terms "oviduct" and "sperm duct" have been used herein as a matter of convenience. What these ducts really are, what their homologies are from the standpoint of comparative anatomy, are questions for which the author has no answer either from his own knowledge or from his acquaintance with the literature in this field.

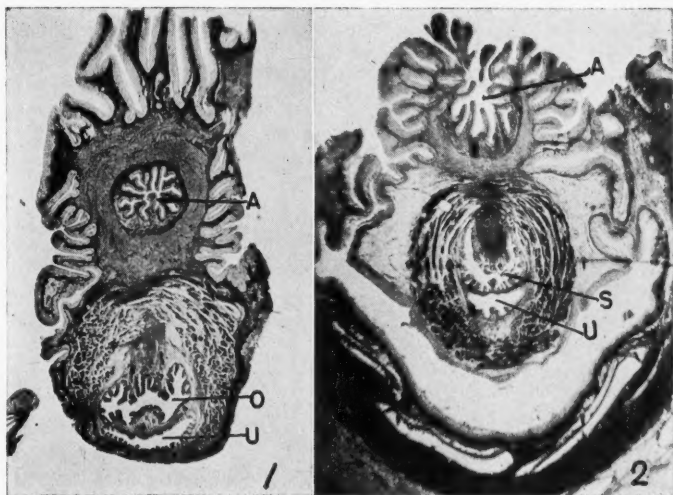


Fig. 1. Female brown trout. Transverse section through anal area and tip of urino-genital papilla showing anus (a), oviduct (o), and urinary duct (u) ($\times 12\frac{1}{2}$).

Fig. 2. Male brown trout. Transverse section through anal area and tip of urino-genital papilla showing anus (a), sperm duct (s), and urinary duct (u) ($\times 12\frac{1}{2}$).

In conclusion the author desires to acknowledge his indebtedness to Mr. W. H. ("Bill") Orsinger for the photomicrographs used to illustrate this article and to the Fish and Wild Life Service for the material that made this investigation possible.

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Partial Analysis of Growth in a Population of Mudminnows, *Umbra limi* (Kirtland)¹

By VERNON C. APPLGATE

INTRODUCTION

THIS growth analysis was made on a collection of 4,005 mudminnows taken from the southeast basin of Kimes Lake, Manistee National Forest, Newaygo County, Michigan, on September 5-7, 1941. Kimes Lake is composed of three distinct depressions connected in serial order by shallow narrows. The southeast basin has an area of 6.75 acres, a maximum depth of about 19 feet, and is entirely marl-bottomed. The dominant vegetation is *Chara*. A spring, flowing at a rate of approximately 35 gallons per minute, is located in the southeast corner. This basin was isolated and the fish were killed with powdered *Derris* root on September 5. Twenty-seven species of fish were in the association. The stickle-back, *Eucalia inconstans*, was the most abundant species; second was the mudminnow, *Umbra limi*. Other species, in decreasing order of abundance, were bluegills, *Lepomis m. macrochirus*, large-mouth bass, *Huro salmoides*, and yellow perch, *Perca flavescens*.

Specimens and habitat data were provided by members of the staff of the Institute for Fisheries Research of the Michigan Department of Conservation. Their cooperation and the assistance of Dr. Karl F. Lagler of the Department of Zoology, University of Michigan, and Dr. Ralph Hile of the U. S. Fish and Wildlife Service, Ann Arbor, Michigan, are gratefully acknowledged.

GROWTH ANALYSIS

Scale Method.—Exhaustive trials were made to assess the age of these fish by the scale method. A selected series of scales from fish covering the entire size range of the sample was examined by means of a compound microscope, a Bausch and Lomb microprojection apparatus, and a Leitz polarizing microscope. The compound microscope and the microprojection apparatus proved of no value in revealing any distinctive markings on the scales. Temporary water mounts examined under polarized light revealed the presence of light bands in the basal (anterior) field of the scales. These bands resembled the annular markings on the scales of those fishes for which the scale method has proven applicable. However, there was no regularity in their appearance on scales of specimens of similar sizes and no numerical consistency in their occurrence on scales from the same fish. It was apparent that with available methods of examination no assessment of age based on the scales was feasible.

It may be concluded that the mudminnow does not form regular annular markings, discernible as such, on its scales. Other fishes indigenous in this region, notably the bowfin, *Amia calva*, also exhibit a lack of year marks. The reason for this is not apparent.

Length-frequency Method.—It is hoped that the following analysis will

¹ Contribution from the Department of Zoology, University of Michigan.

serve two purposes: (1) to make available such information as the data permit on the age and growth of this species; and (2) to illustrate the obvious limitations of using a size-frequency graph alone in age determinations, at least for small, slowly growing fishes.

Most fishes have a more or less sharply defined breeding season, i.e., the young are born during a definite season of the year. If a large collection of a species is made over a short period of time (on one day, for example), the individuals of the sample should group themselves around certain modal sizes. Each of these modes would then theoretically represent an age group or year class. The distinctness of each of these modes would depend on the extent of the overlap of the length-frequency distributions of the consecutive age groups. The overlap would of course depend on the length of the breeding season, on the rapidity and uniformity of growth within the species, and on the length of the period of sampling. The validity of this method for approximate age determination has ample substantiation, and has been applied widely in age and growth studies.

The population of mudminnows under discussion was studied by this method. Optimum conditions, as previously defined, were present in two respects. Since the treatment killed the entire population in a short time the life of all specimens was terminated on the same day. Furthermore, a large sample, estimated at one-third to three-fifths of all those present in the basin, was taken. In addition to the random sample of 4,005 mudminnows saved and used, 3,318 specimens were discarded at the time of collection.

Of the mudminnows preserved for study, 3,992 specimens were suitable for measuring. Measurements were taken to the nearest half-millimeter with a divider and an accurately graduated steel ruler. Both standard and total lengths, as defined by Hubbs and Lagler (1941), were taken on a selected sample of 422 specimens covering the entire size range. From these measurements conversion factors for changing standard to total length were computed (Table I). Only standard lengths were taken on the remainder of the sample.

TABLE I
FACTORS FOR CONVERTING STANDARD (S. L.) TO TOTAL (T. L.)
LENGTH AT VARIOUS SIZES

Standard length (millimeters)	Number of fish	Conversion factor S. L. to T. L.
Under 50	122	1.256
50 - 69	219	1.249
70 - 79	47	1.242
Over 79	34	1.232

The length-frequency distribution (Table II and Fig. 1) was continuous except for the greatest lengths where specimens were not plentiful. Nevertheless two modes, which probably correspond to age groups O and I, appear easily distinguishable. The assumption that the first size group represents the young of the year is not without foundation. As is generally known, most fishes grow more rapidly (in length) in early life than later. This rapid early growth would tend to make the younger size groups more clearly distinguishable in a frequency distribution than the older ones.

Furthermore, since the spawning season of the mudminnow is believed to be in early spring, and this collection was made in September, the size of the members of this first group precludes the possibility of their having been spawned in the previous year. Collections in the University of Michigan Museum of Zoology made in nearby counties were examined and two, made in late May, contained specimens 14.0 and 15.5 mm. long that would support the latter contention.

TABLE II
FREQUENCY TABLE OF STANDARD LENGTHS BY 1 MM. INTERVALS

Midpoint of interval	Frequency	Midpoint of interval	Frequency	Midpoint of interval	Frequency
20.5	1	47.5	120	74.5	3
21.5	1	48.5	104	75.5	5
22.5	6	49.5	102	76.5	1
23.5	25	50.5	84	77.5	1
24.5	57	51.5	75	78.5	5
25.5	97	52.5	100	79.5	2
26.5	147	53.5	49	80.5	2
27.5	164	54.5	43	81.5	5
28.5	174	55.5	38	82.5	3
29.5	179	56.5	33	83.5	..
30.5	179	57.5	41	84.5	..
31.5	129	58.5	33	85.5	1
32.5	114	59.5	37	86.5	..
33.5	80	60.5	26	87.5	1
34.5	60	61.5	22	88.5	1
35.5	56	62.5	20	89.5	..
36.5	78	63.5	13	90.5	..
37.5	111	64.5	14	91.5	..
38.5	146	65.5	10	92.5	..
39.5	136	66.5	14	93.5	..
40.5	173	67.5	9	94.5	..
41.5	176	68.5	10	95.5	..
42.5	148	69.5	7	96.5	..
43.5	136	70.5	4	97.5	..
44.5	108	71.5	5	98.5	..
45.5	120	72.5	3	99.5	1
46.5	141	73.5	3	No length	13

Beyond the second size group, which was assumed to represent yearlings (age group I), the significance of the size distribution in relation to age is obscure. The third mode possibly might represent fish in their third summer. The overlap of the age groups, as presented at this and greater lengths, is probably too great to permit the detection of individual groups in the length-frequency distribution. The chief causes of this overlap probably are:

- (1) Slow growth and the tendency for decreasing growth rate with increasing age to obliterate the distinctness (individuality) of age groups;
- (2) The possible existence of a somewhat extended breeding season regarding which observations are, unfortunately, wanting;
- (3) Lack of uniformity of growth with the effect that faster growing individuals of one group overtake and merge with slower growing individuals of the next group;
- (4) Changing environmental conditions—poor conditions in any given year would adversely affect that year class and if followed by a year class

enjoying more nearly optimum conditions, the former would eventually become submerged, from a size standpoint, within the latter.

As a result of one or several of these factors an early merging of size groups is to be observed between the young of the year (age group O) and the yearlings (age group I) and the larger size groups show a broad, skewed and obscurely polymodal curve. It is improbable that these older fish represent maximum ages greater than five or six years.

The exact size limits of the age groups are obviously not discernible. The average lengths for the first two groups are probably very close to the modes. These may be assumed to be 29.5 mm. for the young of the year and 41.5 mm. for the yearlings.

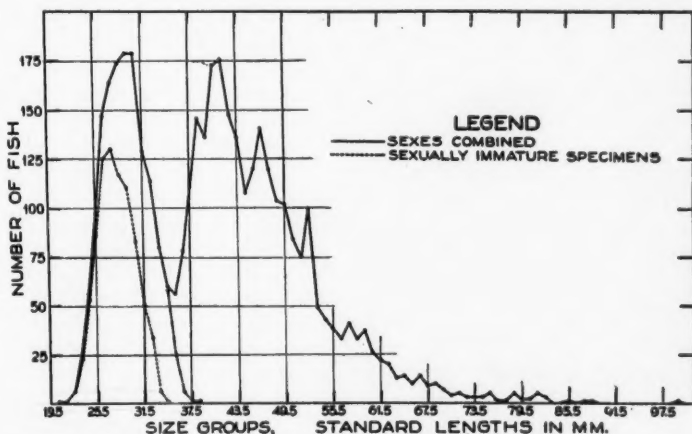


Fig. 1. Length-frequencies in a population of mudminnows, *Umbra limi*.

In order to estimate the proportion of the population made up of young of the year, that group was assumed to approximate a normal curve of distribution. The right arm of the curve was completed so as to be symmetrical with the left as shown by the alternate dot and dash line in Figure 1. An estimate of 1,446 young of the year (36.1 per cent of the total sample) was obtained on this basis. This figure is undoubtedly low since the mechanical difficulties incident to collecting very small specimens after poisoning are manifold.

SEXUAL MATURITY AND SEX RATIO

All specimens were examined for sex and state of development of the gonads. Determinations were made by means of a compound microscope. The numbers and range of individuals exhibiting undeveloped gonads is indicated on Figure 1 and these individuals compose most of the supposed young of the year. Examination revealed that the majority of specimens falling in the second size group had attained sexual maturity. It may be

concluded, therefore, that they were generally capable of breeding at the end of their first full year of life.

Positive sex determinations were obtainable on 3,175 specimens (Table III). No gross sexual dimorphism in length was apparent. There was a slight preponderance of males in the collection; 1720 specimens (54.2 per cent) were males and 1,455 specimens (45.7 per cent) were females. This numerical superiority of males is apparently due to their greater abundance in the smaller size groups. With increasing size and age the relative abundance of males decreases and in the larger and older fish the females show a distinct numerical dominance. This progressive change in sex ratio is detailed in Table III.

There are several possible causes of this observed change in sex ratio. Either the annual increment of growth is greater in the females than in the males or the females possess a greater inherent ability to survive. Perhaps a combination of these two possibilities is the cause. The data show little evidence that the first possibility alone applies. The latter seems to be the most plausible explanation but the reason for the females possessing this greater viability is not known.

TABLE III
PROGRESSIVE CHANGES IN SEX RATIO WITH INCREASING SIZE IN THE MUDDMINNOW
(*Umbra limi*)

STANDARD LENGTH IN MM.	Males		Females		Indeterminable	
	No.	%	No.	%	No.	%
20.0-23.9	1	2.9	..	..	32	97.0
24.0-27.9	41	8.8	30	6.4	394	84.7
28.0-31.9	178	26.9	121	18.2	362	54.8
32.0-35.9	150	48.4	120	37.4	40	14.1
36.0-39.9	280	59.4	191	40.5	..	..
40.0-43.9	355	56.1	278	43.8	..	..
44.0-47.9	243	49.7	246	50.2	..	..
48.0-51.9	199	54.5	166	45.4	..	..
52.0-55.9	119	51.7	111	48.2	..	..
56.0-59.9	69	47.9	75	52.0	..	..
60.0-63.9	35	43.2	46	56.7	..	..
64.0-67.9	21	44.7	26	55.2	..	..
68.0-75.9*	16	40.0	24	60.0	..	..
76.0-99.9*	7	30.4	16	69.5	..	..

* Several 4 mm. size classes combined to compensate for small number of specimens.

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The Status of *Uta ornata lateralis* Boulenger

By JAMES A. OLIVER

THE lizard genus *Uta* (auct.) has long been a poorly understood assemblage greatly in need of careful revisionary study. Mr. Myron B. Mittleman has recently published a series of papers on *Uta* culminating in what purports to be a revision of the genus, in which he proposes a number of taxonomic changes. Close examination of his papers and of the few data presented therein reveals the fact that he has contributed little to a clarification of the status of the forms comprising the group. Many of Mittleman's proposals are difficult to evaluate because of the absence of the data upon which his conclusions are based and because of a confused presentation of certain points. The attempt to find dichotomous differences where only average differences exist has apparently contributed to his confusion.

An occasion arose to examine part of Mittleman's revisionary paper during the course of a study of some of the Mexican reptiles in the collection of the American Museum of Natural History. Difficulties were encountered in attempts to allocate specimens from southern Sonora and northern Sinaloa according to his arrangement. A more detailed examination of the works treating the forms of this region seemed to be in order, in addition to an examination of additional specimens in other collections.¹

A new revision has not been attempted, nor has all pertinent material been examined, but a sufficient number of specimens have been studied to show that Mittleman's arrangement of the forms in this geographic region is not correct. From an examination of 204 specimens of the species *ornata* from Sonora, Sinaloa, and the Tres Marias Islands, it is clear that Mittleman's action (1941b) in synonymizing *lateralis* Boulenger and resurrecting *schottii* Baird is not justified. Nor can his views be accepted that *linearis* and *lateralis* intergrade in northern Sonora in a "belt bordered on the north by the line Reforma-Cananea, and on the south by the line Caborca-Magdalená." These points will be more fully discussed below. Because of Mittleman's misconceptions regarding the status of *lateralis*, it will be redescribed as defined herein and its status considered in some detail.

Uta ornata lateralis Boulenger

TYPE LOCALITY.—Boulenger's cotypes came from the Tres Marias Islands and Presidio, Sinaloa. Both localities have subsequently been listed as the type locality for this form. Statistical analysis of sufficient specimens from the two localities may warrant nomenclatorial recognition of both the insular and mainland populations. It therefore seems advisable to restrict the type locality to one of the two. Presidio, near Mazatlan, Sinaloa, Mexico, is hereby designated as the type locality for *Uta ornata lateralis* Boulenger.

DIAGNOSIS.—A subspecies of *ornata* closely related to *linearis*, from which

¹Specimens in the following collections have been studied: The American Museum of Natural History (AMNH); collection of Dr. L. M. Klauber (LMK); collection of Dr. R. T. Moore (RTM); Museum of Comparative Zoology, Harvard University (MCZ); Museum of Zoology, University of Michigan (UMMZ); collection of Dr. Edward H. Taylor (EHT). I am grateful to the individuals who made possible the examination of these specimens. Charles M. Bogert has been a continual source of counsel and has offered much helpful criticism. Dr. Ernst Mayr has generously contributed statistical aid.

it differs in usually possessing only one complete row of greatly enlarged dorsal scales extending from the nape to the base of the tail on each side of the middorsal line; 23-32 (mean 27.46) scales between axilla and groin in dorsal row of enlarged scales.

DESCRIPTION.—Rostral normally (91.07 per cent) not in contact with internasals; frontal normally (91.07 per cent) divided transversely into two sections, usually (78.58 per cent) broadly in contact with the interparietal; 3, occasionally 4 or 5, prominent, enlarged triangular preauricular scales. Enlarged dorsals commencing on nape and extending, usually in a single complete row on each side of the middorsal line, to the base of the tail; scattered smaller enlarged scales may occur along the outer or lateral border of the complete primary row, occasionally (less than 20 per cent) forming a complete second row between axilla and groin; enlarged scales of the dorsal row 23-32, mean 27.46, between axilla and groin; enlarged scales of the dorsal rows separated along middorsal line by 1-7 scattered and irregularly arranged, slightly enlarged, keeled vertebral scales; a dorsolateral row of enlarged, keeled, mucronate scales separated from the outer edge of the primary row of enlarged dorsal scales a distance approximately equal to twice the width of an enlarged dorsal scale; smaller tubercular scales of lateral area in scattered clusters arranged more or less along one or two longitudinal lines below the dorsolateral row, occasionally arranged in oblique, nearly vertical rows; postfemoral dermal pocket present; femoral pores 8-12; two enlarged postanal scales in males, separated medially by two, rarely one or three, smaller scales.

COLORATION (in alcohol).—Dorsal ground color light brown to dark brown, or more commonly, light to dark gray; a prominent black band extending from the anterior edge of the humerus onto the shoulder and dorsally to the row of enlarged dorsals, but not onto the vertebrae; a horizontal black bar extending anteriorly from this along dorsolateral tubercles of neck; a series of 3-7 vertical black bars on each side of the body normally not crossing vertebral scales; bars reduced to spots, joined anteriorly and posteriorly to form longitudinal bars or stripes, or absent; dorsal surface of legs and tail more or less spotted or barred.

Ventral surface lighter than dorsal; in females generally white to light brown with fine stippling of darker brown or gray, especially along lateral edges; males usually darker below with heavy dark stippling; blue ventral patches variable in size, sometimes reduced on throat to a small central patch at posterior portion, and on belly to two lateral patches separated medially, or so extensive as to occupy all of the throat including lower labials and all of the ventral body surface except the gular fold and a small posterior area between the hind legs; males often with dark blue streaks or flecks on dorsal scales of the head, body, and tail, as well as ventral scales not involved in abdominal or throat blue patches. Both sexes sometimes with a prominent spot of orange on the throat, or orange throat spot entirely absent.

SIZE (snout-vent length).—Thirty-two adult males, 43-55, mean 50.21 mm.; 10 adult females, 44-50, mean 46.00 mm. Specimens with snout-vent length greater than 40 mm. are regarded as adults. This figure represents the minimum observed in females with developing eggs.

SEXUAL DIMORPHISM.—Marked sexual dimorphism is present, as in other mainland Mexican forms of the genus. Data presented above indicate that males attain a larger size (snout-vent length) than females. Males have two greatly enlarged postanal scales which in *lateralis* are usually separated medially by two small scales. Females normally lack these scales, although a few exhibit a pronounced tendency toward such a condition, and one female has the postanals fully developed. In the males, the femoral pores are markedly larger than those of the females, and the pore-bearing scales are differently shaped. In males the pores are several times as large as the small granular scales bordering the pore series posteriorly, while in the females the pores are much smaller than these scales.

There are pronounced differences in coloration between the two sexes. Females lack the ventral blue coloration and are much lighter dorsally than the males. Females frequently lack any dark dorsal maculation between the fore and hind limbs: when the dark maculation is present, it is not as pronounced as in the males. With a little experience, a nearly perfect separation of the sexes can be made on the basis of dorsal coloration alone.

DISTRIBUTION.—The localities listed below are those from which specimens have been examined:

SONORA: Guirocoba (AMNH, MCZ, LMK); Alamos (AMNH, LMK); Agiabampo (LMK).

SINALOA: Ahome (RTM); Culiacan (AMNH); Tres Marias Islands (MCZ).

REMARKS.—In his description of *lateralis*, Boulenger (1883: 342) states, "The two vertebral series of keeled scales formed of much larger, more strongly keeled, and still more regular scales, the length of one of these scales measuring more than half the vertical diameter of the ear opening; the two series bordered on their inner and outer sides by smaller keeled scales."

In this description the words "two series" are open to alternate interpretations: (1) that there are two series of enlarged scales of one row each on either side of the middorsal line; or (2) that there are two series (meaning two rows of enlarged scales) on each side of the middorsal line. Boulenger was comparing his new form (*lateralis*) with *bicarinata* which normally has the enlarged dorsals arranged in one longitudinal row on each side of the middorsal line. Had the second interpretation mentioned above been true, it seems logical that he would have emphasized the presence of two rows on each side more than the size, carination, and regularity of the scales.

The validity of the first interpretation receives further support from Boulenger's statements in the *Catalogue of the Lizards in the British Museum* (1885: 210-16). Here the word series is used to mean one longitudinal row: "a band of six or eight longitudinal series of enlarged dorsal scales, the two median smaller"; "large dorsal scales in four regular series, two on either side of the median smaller ones"; and "a series of very large scales on each side of the vertebral line." This last statement refers to *lateralis* and the author notes also that "they are bordered externally by another series of small keeled scales."

Günther (1902: 61) states, "on each side of the median line, which is

formed by a series of very small keeled scales, there are two rows of large scales, the scales of the inner row being twice or thrice as large as those of the outer." His figure (Tab. XXXI, fig. D), doubtless of one of the cotypes, shows a series of slightly enlarged scales on the outside of each primary row of greatly enlarged dorsals. These scales increase in size posteriorly, so that a short distance anterior to the hind legs those on the left side are nearly as large as the scales of the primary row.

Schmidt (1921: 6) states in regard to *lateralis*, "Enlarged dorsals anteriorly in one row on each side." Van Denburgh (1922, I: 183) indicates precisely the same condition, "Enlarged dorsals normally in one definite row on each side anteriorly." Mittleman (1941a: 66) says, "bordered on either side by one, and then two series of enlarged, prominently carinated, imbricate, regularly arranged scales, those of the inner series being approximately twice as large or larger, than those of the outer series." In 1942 (p. 150), after having resurrected the name *schottii* Baird to replace *lateralis*, Mittleman (1941b: 136) writes: "bordered on either side by two series of enlarged dorsals, of which the primary series is considerably the larger," and specimens lacking two complete rows of enlarged dorsals on each side would be identified as belonging to the species *bicarinata* if only his key were used.

These citations indicate inconsistency in interpretation of the condition of the enlarged dorsals in *lateralis*. These discrepancies might result from: (1) the presence of two really different forms confused under the same name; (2) a highly variable form in respect to this character; or (3) differences in interpretation of the observed condition. It appears that all three of these possibilities have actually contributed to the discrepancies in the literature.

Difficulties in delimiting the subspecies of *ornata* have been due largely to the variability of characters and to the scarcity of critical material. The nature of the enlarged dorsals varies from population to population, but one or another condition is characteristic of each race. Thus despite some overlap, the races of this species can be based in part on the character of the enlarged dorsal scales. This character has been sometimes erroneously reported and has been subjected to divers interpretations. For example, a lizard may have one prominent primary row of greatly enlarged scales on either side of the vertebral line; bordering these laterally are scattered scales, much smaller in size yet larger than the adjacent granular dorsals. Should this condition be reported as two or as one row of enlarged dorsals on each side of the vertebrals? Since Günther (*supra cit.*) lists no specimens other than the cotypes, it appears that he placed a different interpretation on the identical character. Large series of specimens exhibit great variation in the enlarged dorsals. Confusion regarding this character has been due to the failure of authors to indicate precisely the condition being described.

In specimens of *ornata* from Sonora the condition of the enlarged dorsals can be referred to one of four arbitrary categories:

(1) Indicated I - I. In this category there is only a single distinct, prominent row of greatly enlarged scales on each side of the smaller vertebral scales. A few scattered, slightly enlarged scales may be present along the outer or lateral border of the row, especially posteriorly. The outer enlarged scales, if present, do not form a definite row (scales in contact) extending

for a distance equal to half the axilla to groin length.

(2) Indicated I+ - I+. In this category there is only one distinct, prominent row of greatly enlarged scales on each side of the smaller vertebral scales. Slightly enlarged scales are present along the lateral border of the primary row, especially posteriorly. These scales form an outer row (scales in contact) extending for a distance of more than half the axilla to groin length, but not more than three-fourths of this distance.

(3) Indicated II - II. In this category there are two distinct, prominent rows of greatly enlarged scales on each side of the smaller vertebral scales, the scales of the outer row one-fourth to one-half as large as those of the primary row.

(4) Indicated II+ - II+. In this category there are two distinct, prominent rows of enlarged scales on each side of the smaller vertebral scales. In addition slightly enlarged scales are present along the outer or lateral edge of the secondary row. These slightly enlarged outer scales may form a row as described above in category 2.

Comparing specimens from four Sonoran localities the condition with respect to the above categories may be shown in tabular form. The Pilares specimens (northern Sonora) represent a population referable to the race *linearis*; the Guaymas specimens (western central Sonora) represent an intermediate population of intergrades between *linearis* and *lateralis*; the Guirocoba and Agiabampo populations (extreme southern Sonora) represent the race *lateralis*.

Locality	I - I	I+ - I+	II - II	II+ - II+
Pilares (UMMZ-38)	0	0	64.42% (26)	31.57% (12)
Guaymas (EHT, MCZ, UMMZ-39)	0	7.69% (3)	92.31% (36)	0
Guirocoba (AMNH, LMK, MCZ-27)	55.55% (15)	25.94% (7)	18.51% (5)	0
Agiabampo (LMK-23)	52.17% (12)	34.79% (8)	13.04% (3)	0

The majority of specimens of *lateralis* (Guirocoba and Agiabampo in above table) do not have two rows of enlarged dorsals on each side of the vertebral line. In fact, more than 50 per cent have only a single definite row on either side.

In an endeavor to obtain a quantitative difference between the lizards of northern and southern Sonora, the enlarged dorsals of the primary row were counted between the axilla and groin, from a point opposite the anterior insertion of the fore legs to a point opposite the anterior insertion of the hind legs. The data obtained for specimens from the four previously mentioned localities are presented in Figure 1. The pertinent statistical information is tabulated below.

	Pilares	Guaymas	Guirocoba	Agiabampo
No. specimens	38	34	26	21
Mean \pm 3 S.E. ¹	34.60 \pm 1.00	30.41 \pm 1.02	27.76 \pm 1.13	27.09 \pm 1.61
S. D. \pm 3 S.E.	2.07 \pm 0.70	2.08 \pm 0.75	1.92 \pm 0.80	2.46 \pm 1.18
V. \pm 3 S.E.	5.45 \pm 1.87	6.14 \pm 2.23	7.40 \pm 3.06	11.73 \pm 5.43

¹ Abbreviations used above are: S.E., standard error; S.D., standard deviation; V., coefficient of variation or of variability.

A series of 20 adults from several localities in southern Arizona agrees well with the Pilares population in this character while the Sinaloan and Tres Marias Island specimens agree with the populations from Guirocoba and

Agiabampo. It will be seen from an examination of these data that the Pilares series is well differentiated from the Guirocoba and Agiabampo series. The Guaymas specimens are intermediate. Dr. Ernst Mayr, of the American Museum of Natural History, has supplied a formula for measuring statistically the percentage of non-overlap in the calculated population range for this character and calculated this for the Pilares and Guirocoba populations: 95 per cent of the Pilares population are separable from 95 per cent of the Guirocoba population.

Mittleman (1941a: 68-69) separates *lateralis* from *linearis* as follows:

In the former, the enlarged dorsals commence well craniad of a line joining the anterior points of insertion of the forelimbs; in the latter race, these commence either slightly craniad of a line such as this, or else distinctly caudad of it. In *lateralis* the scales of the inner series of enlarged dorsals are at least twice the size of the scales of the outer series; *lateralis* also possesses a prominent dorsolateral series of spots. *U. o. linearis* possesses no regular, distinct series of dorsolateral spots, nor is there a very appreciable difference in size between the scales of the outer and inner series of enlarged dorsals.

The beginning of the rows of enlarged dorsals anteriorly is not abrupt and arbitrary criteria are necessary to establish at which point these rows begin. There is considerably more individual variation in this character in *linearis* than there is in *lateralis*. That this character is subject to various interpretations is shown by the following passages (Mittleman, 1942): where *linearis* is differentiated from two related forms in which these scales begin caudad to the anterior point of the arm insertion, he states (p. 138), "enlarged dorsals usually commencing just craniad of a line joining the anterior points of insertion of the fore-limbs;" in comparison of *schottii* (= *lateralis*) and *linearis* he notes (p. 151) "whereas in *linearis* they [enlarged dorsals] commence about equal with a line joining the anterior points of insertion of the fore limbs."

In *lateralis*, as recognized herein, the enlarged dorsals begin on the nape where they form two (one on each side) prominent, keeled, median ridges. In *linearis* from northern Sonora, the scales on the nape are usually somewhat enlarged on the middorsal line, but are not arranged in two prominent, keeled, median ridges. Specimens from Guaymas, and occasional ones from farther north, may exhibit either condition or occasionally they may have four rows (two on either side) of well differentiated enlarged scales on the neck.

Concerning Mittleman's second character, it has already been pointed out that in more than 50 per cent of the *lateralis* examined in this study, there is no outer row of enlarged dorsal scales. In those individuals with an outer row, the scales of the inner row are at least twice as large as the outer ones. Specimens of *linearis* from northern Sonora show a tendency to have somewhat smaller outer scales than some Arizona individuals, but these are at least half as large as those of the inner row, especially on the posterior half of the body.

In coloration, both forms exhibit marked variation and I have observed no consistent differences. Observations made in this study do not agree with those of Mittleman who states that "melanistic specimens of *lateralis* are quite common throughout Sonora" (1941b: 138); and "In *linearis* there is no

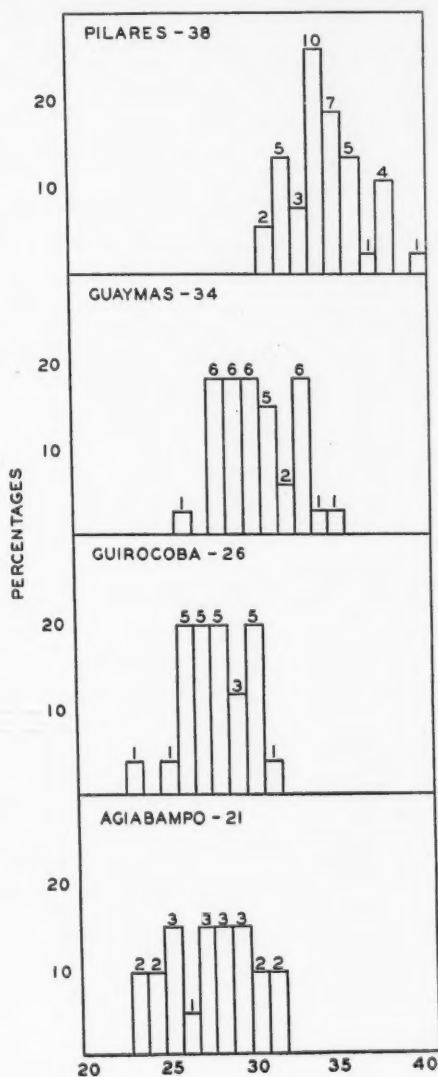


Fig. 1. Histograms showing the variation in the number of enlarged dorsal scales between the axilla and groin in four Sonora populations (arranged from north to south). Percentage frequency shown by scale; actual frequency by figure on column.

prominent pattern of dorsolateral spots in series, while in *schottii* [= *lateralis*] such a pattern is distinctive and always present, save in melanistic individuals" (1942: 151). No specimens have been seen by me which could be considered melanistic (namely, with sufficient black pigment present to obscure body markings). Mittleman's statement (1942: 122) "that with no known exception, the lizards of *Urosaurus* are very prone to exhibit a uniformly melanistic appearance," seems to be founded on fancy or possibly on poorly preserved formalin specimens. The second statement above is equally doubtful; a number of females have been examined that completely lack the "distinctive and always present" pattern referred to.

It might be inferred on the basis of the foregoing remarks that Mittleman possibly has not studied specimens of the form referred to here as *lateralis* and consequently was unaware of its characters and status. While the latter assumption is certainly true, the former is not. In the course of this study, as mentioned above, material has been examined in other collections. The bulk of the material examined was the same that had been borrowed and studied by Mittleman. It was hoped that an examination of such material would offer a clearer concept of his proposals.

TABLE I

Character	COMPARISON OF <i>lateralis</i> AND <i>tuberculata</i>	
	<i>lateralis</i> (56)	<i>tuberculata</i> (20) topotypes)
Rostral-internasal	91.07% separated	95% in contact
Frontal	91.07% divided transversely into two sections	50% divided transversely and posterior section longitudinally to form 3 sections; 44.45% undivided
Frontal-parietal	78.00% in contact	94.45% separated
Preauricular scales	3, occasionally 4 or 5, large, flap-like, triangular and non-tubercular scales	1 or 2 enlarged tubercular scales
Enlarged dorsals	Regularly arranged with prominent raised keel, roughly hexagonal in shape, as long or longer than broad, narrower anteriorly than posteriorly	Somewhat irregular with low rounded keels, roughly oval in shape, broader than long and not narrower anteriorly than posteriorly
Lateral tubercles	Arranged in 2 or 3 longitudinal rows, upper more prominent than others and separated from outer edge of primary row of enlarged dorsals by distance approximately equal to twice width of an enlarged dorsal scale	Arranged in 4 or 5 longitudinal rows, upper no more prominent than others and separated from outer edge of primary row of enlarged dorsals by distance approximately equal to width of an enlarged dorsal scale
Postanal scales of males	94.12% separated by two, rarely one, smaller scales	100% separated by three, occasionally four, smaller scales

He states (1941a: 74) under remarks on *U. bicarinata tuberculata*, "In the course of an examination of Mexican Utas in the collection of the Museum of Comparative Zoölogy I came upon two specimens, M.C.Z. nos. 37856-7, collected near Guirocabo [*sic*], 20 miles southeast of Alamos, Sonora. These two specimens are quite typical of the subspecies [*tuberculata*] . . ." My

examination of the material in this same collection reveals that MCZ 37856 which Mittleman considers "quite typical" of *tuberculata*, is actually an easily recognizable specimen of *lateralis*.

A number of characters serve to separate *tuberculata* and *lateralis*, races of different species. Mittleman (1942) utilizes in his key the number of longitudinal rows of enlarged dorsals on either side of the back, the condition of the frontal (divided or undivided), the presence or absence of a postfemoral dermal pocket, and the nature of the ventrals, to separate the species to which these races belong. These characters do not provide a satisfactory basis for separation of the two forms. *Uta o. lateralis* and *b. tuberculata* are superficially close to, but do not represent, a connecting form between their respective species. Despite some morphological convergence and overlap, the two species manifestly are biologically distinct. The two races occur side by side without any evidence of intergradation throughout a region more than 300 miles long where their ranges overlap. Table I presents several structural characters indicative of the differentiation of these forms. There are also differences in coloration.

MISCELLANEOUS COMMENTS.—As stated previously, no attempt has been made here to make a revisionary study nor to check Mittleman's work in its entirety. Since so many statements in his work are without presentation of evidence such a check would be a laborious task. Certain items encountered in my perusal of his papers warrant comment.

Some index to the quality of his "revision" is provided on page 155 (1942), where he states:

Because there is a greater quantitative dimorphism between the sexes of this species, than in any other form yet observed, the mensural data have been correlated as given below, based on forty specimens (twenty-two males, eighteen females) of adults:

Measurement or ratio	Males	Females	Mean of all specimens
Head length	10.5-11.7-13.0	9.0-10.4-12.5	11.17
Head width	8.0- 9.4-10.0	7.0- 8.3-10.0	8.92
Head length/head width [<i>sic</i>]	75.0-80.5-87.0	75.0-79.4-87.0	79.25
Snout to vent	40.0-46.5-52.0	34.0-40.2-51.0	43.35
Hind leg	23.0-28.1-30.5	21.0-24.6-29.0	26.22
Tail length	68.0-73.5-80.0	51.0-61.4-77.0	67.46

The left and right figures represent the lowest and highest measurements and/or ratios obtained; bold [italicized] figures are the means.

All that these figures reveal is that one, and only one, character is involved in the sexual dimorphism, namely, size expressed in terms of length. This dimorphism could be expressed in a simple statement to the effect that males probably attain a larger size than females, and there is no necessity for reproducing the columns of figures, which are misleading, since at first sight it appears that several characters are involved. The differences between the means may or may not be of statistical significance. Mittleman admittedly labors under the impression that statistical methods cannot be applied to the lizards of this genus. Males of all mainland Mexican *Uta* appear to attain a larger size than females. This difference in size can be expressed best in terms of measurements of the snout to vent length. But there is no proportionate difference in head length, head width, hind leg length, nor tail length between

the sexes of *gadovi* as recorded in the table above. The ratios of head width/ head length, head length/ snout to vent length, hind leg length/ snout to vent length, and tail length/ snout to vent length are all practically identical figures for the two sexes. Furthermore, Mittleman's "head length/ head width" ratio is a misstatement for the head width/ head length ratio, and some error is involved in his mean "head length/ head width" ratio of all specimens since it is impossible to obtain a combined figure below the respective mean of each group.

Mittleman (1941a: 74) described USNM 14248, a female from Chihuahua, Mexico, as the type of *unica*, a "very unique species." Because of the necessary precautions of safeguarding type specimens during the present world strife this specimen has not been examined and an opinion can be based only on statements in the literature. Cope's (1900: 320) comments and figure (fig. 43) of this specimen indicate nothing beyond the range of variation in *Uta bicarinata tuberculata* of Schmidt. Furthermore, the origin of the specimen appears to have been Batopilas, a town situated on the western side of the Sierra Madre Occidental on the Rio Fuerte drainage. There is no indication that any physical barrier exists between the *tuberculata* populations of southern Sonora, northern Sinaloa, and Batopilas, Chihuahua. Numerous species are common to all three localities. Mittleman (*loc. cit.*) has not presented any valid characters that place the single specimen beyond the range of variation in *tuberculata*. In addition, he seems somewhat confused regarding the size of his *unica*: (1941a: 74) "a medium-sized *Uta*"; (1941a: 76) "insofar as it can be determined, *unica* represents a dwarf offshoot . . ." This is hardly a valid conclusion based on a single specimen. The type, and only known specimen, is an adult female, apparently containing developing eggs, with a snout to vent length reported by Mittleman to be 50 mm. This specimen can scarcely represent a "dwarf offshoot" of any known mainland Mexican *Uta*; if Mittleman's figure is correct the specimen must be recognized as an adult female with a snout to vent length well above the average for females of any closely related form.

In a discussion of the phylogenetic significance of a character, there is scant justification, on the basis of a single specimen, for the statement that any character "is always present in *unica*."

Mittleman (1942) would split the genus *Uta* into four genera, placing the species *ornata* in the genus *Urosaurus* Hallowell. His action seems to be of doubtful value, even for the sake of convenience. There is no greater divergence between some species placed in his restricted *Uta* and some placed in *Urosaurus* than exists between certain species within the genus *Uta* or between certain species within the genus *Urosaurus*. Furthermore, in the separation proposed, *nigricauda* and *microscutata*, which in all probability are races of a single species, are intermediate between the two groups, making any such separation highly artificial.

Mittleman's presentation of characters in his "Diagnosis," under the various generic headings, is misleading and represents more rhetoric than zoology. Certain characters are listed only under one genus, while examination shows several of the characters mentioned are identical or similar in the various genera he seeks to erect. For example, the sternal fontanelle, listed

only under *Uta* (*sensu* Mittleman), is present in representatives of all of his four genera. Other characters are insufficiently or carelessly analyzed. Under *Uta* (*sensu* Mittleman) for instance, he states "postfemoral dermal pocket present." *Uta stansburiana stejnegeri*, which he would place in this restricted genus, regularly lacks this structure in females and it is rarely present in males. Finally, the "Diagnosis" of the proposed genera is padded with such meaningless phrases as "labials segmental," a character of value only in distinguishing the Squamata from the Testudinata.

Until more valid reasons are presented for erecting four genera for the species placed in the genus *Uta* (in a broad sense), these species should be considered congeneric. Infrageneric groups can probably be diagnosed, but their nomenclatorial recognition is not useful until the variation within the species has been adequately analyzed.

SUMMARY.—Renewed studies show that *Uta ornata lateralis* Boulenger is a valid form occurring in southern Sonora, western Sinaloa, and on the Tres Marias Islands. *Uta ornata schottii* Baird is a synonym of *Uta ornata linearis* Baird. There is no justification for Mittleman's action in recognizing four genera to accommodate the species placed in *Uta* prior to his proposal.

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Notes on Captive-bred Snakes

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SNAKES born in captivity from females impregnated in the wild are common in all collections, and snake eggs are hatched by many reptile keepers each year. The breeding of snakes in captivity, however, and the rearing of the young, is of much rarer occurrence. It is hoped that the following notes will bring comments from those who have had experience with captive-bred snakes.

Both *Natrix* and *Thamnophis* breed here at the San Diego Zoo in the outdoor pit, where conditions are practically the same as in the wild. In the Reptile House the temperature in the corridors containing the cages never falls below 80° F. In the warmer months the temperature is higher in the daytime, but for a good part of the year it remains constant at 80°.

In one of the cages in the Reptile House a pair of *Crotalus ruber*, both captured in December, 1936, were observed in copulation about 7:30 A.M. on February 18, 1937. Unsuccessful courting of short duration had been noticed on February 6 and also on Feb. 11. At the time they were first noticed together there was a pumping movement in the tail of the male, a rhythmic motion that resembled breathing. At one time the male made jerky courting movements with his head. Several times the female dragged the male across the cage for a distance of about 2 feet. In the afternoon there was a rhythmic motion in the posterior part of the body of the female, which appeared to be caused by the pumping movement of the male. Most of the time, however, they were quiet. There was no change at 4:30 P.M. and they were apart the following morning. On August 10, 1937, 172 days later, the female gave birth to three young and passed three bad eggs. One of the young measured 340 mm. (about 13½ inches) in length. The babies began feeding on a small mouse apiece each week and now are eating good-sized rats at intervals of two weeks. They are now almost 4 feet in length. Two of them have broken off one or more segments of the rattle but the third has a complete string of fourteen.

Another pair of *C. ruber* was seen in copulation on March 26, 1941. The female has been in captivity since June, 1936. The male was captured by Robert Arganbright in Borego on the night of June 18, 1937. The male had been courting almost every day since March 14, 1941, but nothing more was expected as he had done the same thing every spring since 1938. His courting followed the usual pattern—he did not nudge the female. They mated some time between 2:15 and 3:00 P.M. There was a slight "breathing" movement in the tail of the male. The pair often moved around the cage. They were apart the following morning. The young were born on August 14, 1941. Possibly there had been an earlier mating as the period was only 141 days instead of 172 days as it had been for the other pair of *ruber*. The length of time in captivity might have had something to do with the difference if no earlier mating occurred. When first observed, at 9:10 A.M., one normal and two premature young had been born. (The small or deformed young, often dead, with a lot of egg yolk attached, are referred to as premature; possibly "defective" would be a better word.) From then until 2:06 P.M.

two more normal young had been born, although one of them had a protruding eye ball. There was a total of three normal, three prematures, and seven bad eggs during that time. There was no change at 5:05 P.M. when last observed although obviously there were more coming. The following morning there was another bad egg in the cage and no change until the third morning, when a normal but dead snake finished the brood.

A pair of *C. basiliscus*, born in the Zoo on June 27, 1938, were noticed in copulation about 4 P.M. on August 17, 1940. No previous courtship had been seen. There was a slight tail movement on the part of the male. He was also active in the anterior third of his body, the head moving along the back of the female in typical courting fashion. They were still together but quiet at 9:30 the next morning. At 9:45 A.M. the female apparently was trying to get free and they parted between 10 and 10:12 A.M. They bred at the age of two years, one month, and twenty days. Something went wrong and although the female got heavier and looked pregnant, no young were born.

As mentioned above, the courtship before the mating was not witnessed, but the same male courted another female on January 28, 1941. The female had shed on the 26th, an occurrence which often seems to excite the male, but this time had no effect, possibly due to the fact that he also was about ready to shed. This he did about 9 A.M. on the 28th. About 10 A.M. on that day both snakes were seen crawling about the cage; they were not noticed again until 11:50. At that time the female was lying quietly with the posterior part of the male's body across hers. He was making jerky movements with the anterior half of his body. His tongue was flicking along the anterior third of her body and he constantly nudged her rather forcibly with his chin. His tail was under and partially around hers when they were first observed, and it remained there throughout the day. About every four minutes he gave a convulsive jerk with his tail and at once drew back his head and neck as though to strike and remained quietly in that position for perhaps a minute, and then started the nudging again. There had been no change when they were last observed at 4:15 P.M. The female had not moved all afternoon. The following morning they were in opposite corners of the cage and probably no mating had occurred.

The same pair of *C. basiliscus* that mated (with no results) on August 17, 1940, mated again on August 31, 1941. This was the Sunday before Labor Day and the holiday crowd was so large that, although courting was observed at infrequent intervals, the time the actual mating started was not known. It was first noticed at 4 P.M. The male had been courting another female in the same cage for several days. The following morning the "breathing" movements in the tail of the male were noticed at each observation. They separated about 10:50 A.M. The male was courting the other female while mating.

A female *Pituophis catenifer annectens* which had been in captivity since July, 1936, laid seven eggs during the night of July 1, 1939. Mating was not observed. The eggs hatched on September 6, 1939, after an incubation period of sixty-seven days. The young averaged 408.4 mm (about 16 inches) in length when hatched. Two specimens kept alive have done well on a diet of one small rat apiece each week and now are about 4 feet, 3 inches in length.

In July, 1936, four *P. melanoleucus* were received from T. P. Haines at the University of Michigan. Two of these died soon after, but two are still on display in the reptile house. Mating was not observed but the female laid six eggs on April 28, 1940. These hatched on July 15, 1940, 78 days later. A young specimen measured 509 mm. (about 20 inches) in length. One of them refused food several times and was preserved. The other five have done splendidly and are now taking a small rat apiece once a week and are about 44 inches in length.

The same pair mated on January 3, 1941. No courting was observed, but about 11:15 A.M. they were noticed in copulation. The male had the female by the back of the head and neck on her left side, in typical *Pituophis* fashion. Although he held her firmly he was not biting hard. The male was making jerky motions that moved his whole body. His tail was not entwined around hers. There was no movement of the female noticed at any time. They were observed at fifteen minute intervals, and the male was very active each time up to 12:15 P.M. At 12:30 and 12:45 they were quiet but the male still held her by the head. At 1 P.M. they were apart. The female laid six eggs on February 5. These hatched seventy-nine days later, on April 25, 1941.

Three weeks after the mating of January 3, 1941, the male was observed at 12:30 P.M. making jerky courting movements along the back of the female. At 1 P.M. the male had the female by the neck at the back of her head. The female was about to shed and did so the following day. The male was wriggling the anterior half of his body along the back and sides of the female. The ventrals on the posterior half of his body were moving with a wave-like motion, although that part of his body was otherwise motionless. His tail was wriggling rapidly for its whole length, but not with the vibrating motion of nervousness. Every few minutes he made a sweeping motion with his tail, which was partly over and partly at the side of her tail but not entwined around it. At 1:35 the male released the female's head but continued the same movements as before. When next observed at 1:55 he was quiet and at 2:15 was away from her on the far side of the cage.

A pair of *Elaphe laeta* was received in May, 1937, from Willis Woolems of San Antonio. Mating was not observed, but the female laid one egg on July 8, 1940, and thirteen more the following morning. These were divided into two batches, one of which became too moist and soon spoiled. In the other batch, hatching started seventy-two days later on September 18, 1940. Only two of these hatched. The other five were in perfect condition but the snakes seemed to have been unable to slit the shells, which were exceptionally tough—much tougher than the shells of the eggs of two other *laeta* females which hatched a short time later. The young measured 242 mm. (about 9½ inches) at birth, and were fed a small mouse apiece once a week. In November, 1941, they were about 29 inches long.

Adrian Vanderhorst brought a pair of *Alsophis angulifer* from Cuba in April, 1939. The female laid nine eggs on August 24, 1939, which hatched on November 27, 1939, an incubation period of 95 days. The snakes averaged 230.4 mm. (about 9 inches) in length. The following year on May 28, 1940, about 9:45 A.M., the adults were noticed in copulation and were still paired at 5:10 P.M. There was very little movement on the part of

either snake. The cloacal region of the female was very much distended, and although they were apart the next morning it remained so during the day. Another copulation may have occurred, as the male had been seen trying to mate several days before. Eight eggs were laid during the night of August 17, 1940, eighty-one days after the observed mating. The first of the eggs started to hatch on November 14, 1940, and the fourth young snake came out of its shell on the 19th. The other four eggs failed to hatch, although the embryos were well developed. The incubation period was eighty-nine days. The young averaged 255 mm. (about 10 inches) in length. The 1939 eggs were incubated in an unheated room, whereas those laid in 1940 were kept in a room in which the temperature never fell below 80° F. This may account for the difference in the number of days from laying to hatching. Although they were offered earthworms, meal worms, strips of fish and frog meat, as well as newly born mice, none of the young snakes would eat. These are our only captive bred snakes that have failed to eat.

The same pair mated again on May 27, 1941, this time in the water trough. They were first noticed at 10:15 A.M. and were apart the next morning. There was very little movement on the part of either snake. The cloacal region of the female remained swollen for a day after they separated, as it had the year before. Nine eggs were laid on July 29, 1941, and are due to hatch about the first of November.

A pair of *Coluber lateralis* mated on April 1, 1941. No previous courting had been observed. The female dragged the male around the cage, not only on the ground but backward up into the small tree. The tail of the male was not entwined around that of the female. The pumping movements of the male occurred at the rate of eleven to the minute when first observed at 11:50 A.M. These slowed down to five by 12:15 P.M. and to about one per minute at 1:02 P.M. No more pumping was noticed and they parted between 2:10 and 2:25 P.M. Eight eggs were laid on May 27, 1941. These were handled in the usual fashion but for some unknown reason soon spoiled.

During the night of June 16, 1941, two female *Elaphe quadrivittata* laid a total of nineteen eggs. Eight more had been laid a day or so before, making a total of twenty-seven. These were divided into three batches and all spoiled in a short time. Both females have been here since 1937, the male since 1940.

Since 1941, when the above was written, we have had several more captive-breeds, the most interesting ones netting us two broods of *Crotalus*. One of these was from the same parents (*C. ruber*) that bred on March 26, 1941, the female giving birth to young 141 days later. In 1942 mating occurred on March 29, and the young were born 154 days later on August 30, 1942. This year (1943) the same pair mated on March 21.

The method used in the hatching of snake eggs may be of interest. The container is a crock about 6 inches in diameter and 4 inches deep. A paper towel is folded into a square, thoroughly soaked, and the surplus water squeezed out by hand. This towel is placed in the bottom of the crock and covered with a dry paper towel folded in the same way. The eggs are placed on the towels and the crock covered with a pane of glass. The eggs are put in the crocks as soon as laid unless the laying is done

during the night, when they are taken care of the following morning. Usually nothing more is necessary. Occasionally there is too much moisture and, although the cover is temporarily removed to lower the humidity, the eggs often spoil. Some molds or fungi seem to do no harm while others are fatal. Much more rarely the eggs get too dry and start to shrivel, and a little water is added.

The incubation takes place in an unheated room with west windows. The temperature at night rarely falls below 75° F. and occasionally rises as high as 90° F. during the daytime when the sun shines through the windows.

The young snakes are offered food as soon as they have shed for the first time. No force-feeding is done.

This egg-hatching technique has proven very satisfactory, although in only one season (1939) was the hatch 100 per cent. For four years we have had an average of sixteen batches of eggs each year, including both captive-bred and wild-bred, and the average hatch for the whole period was 73.22 per cent. Unless something unforeseen happens to the one remaining batch, this year's hatch will be 76.93 per cent.

ZOOLOGICAL SOCIETY OF SAN DIEGO, SAN DIEGO, CALIFORNIA.

Continued Fertility in Female Box Turtles Following Mating

By H. E. EWING

LIKE other observers of the habits of box turtles the writer some years ago noted the frequency with which matings take place early in the fall before the turtles go into hibernation. Since these matings appeared to be as frequent and as successfully completed as those in the spring, he considered it probable that they result in the fertilization of the eggs laid during the summer of the following year. Observations relative to a single female showed that this was true. The results were reported (Ewing, 1933) in a short note in COPEIA. Following this preliminary experiment the literature relative to the length of the fertile period in turtles following mating was reviewed. It was found that Hildebrand (1929) had already observed that in the diamond back terrapin, *Malaclemmys*, females produce a high percentage of fertile eggs for two years without recopulation, after which fertility rapidly drops.

Having acquired this information, an experiment with isolated females was started. On September 30, 1933, four mature females of the eastern box turtle, *Terrapene carolina carolina*, that had been long associated with males, together with a virgin female and two young, were placed for observation in a large, high-walled vivarium.

The vivarium was situated at the back end of my garden next to the woods. It was 16 feet long, 8 feet wide, and walled with vertical boards to a height of 6 feet. The top was open, while entrance was obtained at one end through a door which at all times was kept locked except when used by the writer. At the other end was a small observation window, about 4 feet from the ground. This window made possible observations without disturbing the turtles. Inside this large vivarium grew two small mulberry trees and various herbaceous plants.

Of the two young turtles placed in the vivarium on September 30, one died during the winter of 1935-36, and the other grew into an adult virgin female and is alive today.

The four adult females that had been previously associated with males all proved to be fertile. Their egg-laying record, as far as known, is here given, each turtle being recorded according to the number painted on its carapace, the abbreviation referring to the color of paint used.

A large, uninjured female, Or.3, laid four eggs in 1934, three of which were fertile and one not fertile. In 1935 she laid a single egg in a nest which was only partly covered over. The egg was eaten the next day by another box-turtle. In 1936 this female laid five eggs, of which four were fertile and one infertile. In the following years, 1937 to 1940, Or.3 was not observed to make a nest.

A medium-sized female with most of the tail gone, Or.23, was not observed to make a nest in 1935. In 1936 she made an abnormal nest, a trench instead of a hole, which was filled in without eggs being deposited. In 1937 this individual laid two eggs of which one was fertile and one infertile. After 1937 she was not observed to make a nest.

A small female with a scar in the carapace, Or.30, made two nests in 1934. In the first were two eggs, one of which was cleaned out by ants and the other was infertile. In the second nest three eggs were laid, all fertile. In 1935 Or.30 laid three eggs, two fertile and one infertile. In 1936 a single infertile egg was laid. In 1937 two infertile eggs were laid. In 1938 a single infertile egg was found. The same was true of 1939. In 1940 no nest was observed, although this female may have made one unobserved.

A medium-sized, uninjured female, Or.38, laid three or more eggs in 1934, at least one of which was fertile. She was not observed in the act, but undoubtedly was responsible for one of the three nests found after they had been filled in. She probably laid eggs in 1935, but the nest could not be located. In 1936, Or.38 laid six eggs of which five were fertile and one infertile. In 1937 she laid five eggs, all fertile. In 1938 six infertile eggs were laid. In 1939 five infertile eggs were laid, as was the case in 1940.

From these data it is evident that one of the mated females retained her fertility for two years after being separated from males, another retained it for three years and two for four years. Of the latter two, one, Or.38, laid in her fourth year following separation from the male a clutch of five eggs all of which were fertile.

Of the eggs reported as fertile during this experiment, each either had upon opening a large embryo or was allowed to hatch in the normal way. Thus the one fertile egg of the three laid in nest G in 1934, was opened on

November 11 and found to contain a large but dead embryo. On the other hand, five of the six eggs laid by Or.38 hatched giving normal living young. One of these five had already emerged by September 22, two emerged the following day, and by September 27 all five were out.

DISCUSSION.—That fertility in reptiles other than turtles may extend for months or even years has been established by certain other workers.

Woodward (1933) found that the female of the African night-adder, *Causus rhombeatus*, when kept away from the male in captivity, retained her fertility for at least five months. During this period she produced four clutches of eggs, the first and second being 100 per cent fertile, the third 64.7 per cent fertile, and the fourth 55.5 per cent fertile. All eggs produced after the fourth clutch were infertile. Kopstein (1938) confirmed long delayed fertilization in certain Malaysian snakes. Haines (1940) kept a female of the Central American snake, *Leptodeira annulata polysticta*, isolated in captivity, that laid a clutch of eleven eggs more than four years after the snake was obtained; six of these eggs exhibited a red area, the area vasculosa, and one of them possessed a living embryo. These fertile eggs must have been laid at least five years after the last possible copulation. Haines raises the question as to whether this production of successive clutches of fertile eggs by isolated female reptiles represents parthenogenesis or delayed fertilization. The mere fact that every known instance of continued production of fertile eggs in isolated reptiles after the laying of the first clutch of eggs leads, in a few months or years, to the production of infertile eggs would appear to rule out parthenogenesis. Furthermore, the present writer has reared to maturity a few isolated females of the eastern box-turtle. In each instance no eggs were laid without copulation.

Kopstein (1938) was much impressed by the physiological process which enabled his snakes to lay more than one clutch of fertile eggs after a single copulation and called it *Amphigonia retardata*. Until we are better informed in regard to the exact nature of the process involved such a designation probably should be used with some caution. In many insects the female is provided with a receptaculum seminis in which the sperm of the male is stored following copulation, the spermatozoa remaining viable for months or even years and being doled out sparingly as needed to fertilize the eggs.

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The Correlation of Variability Within and Between Rattlesnake Populations

By L. M. KLAUBER

A CORRELATION between the degree of variability of a character within a homogeneous population and the extent of the difference of the same character between related populations might well be expected. That is, the more variable a character, the more plastic it might be assumed to be, and hence the more subject to selective and ecological pressures. Thus, the degree of the difference between populations would tend to be greater in the more variable characters.

This correlation has been investigated for seven characters, scale rows, ventral scutes, subcaudal scales, supralabials, infralabials, body blotches, and tail rings, in six pairs of rattlesnake populations. The series used were all from relatively restricted areas to avoid the complication of territorial variation within a sample.

The coefficient of variation has been used as the measure of intrapopulation variability, and the coefficient of divergence as the measure of interpopulation difference.¹ The mean between the two coefficients of variation of each character of each pair was taken as the figure to represent that character in the correlation analysis. In the characters manifesting considerable sexual dimorphism (ventrals, subcaudals, and tail rings), the coefficients were computed separately for each sex and were then averaged, the single average figure being taken to represent that character.

The following population pairs were utilized in the computations:

- (A1) *Crotalus cinereus* (42 males, 27 females) from the Colorado Desert of extreme southeastern California; and (A2) the same species (76 males, 63 females) from San Patricio, Texas.
- (B1) *Crotalus lucasensis* (193 males, 145 females) from the Cape region of Lower California; and (B2) *Crotalus ruber* (137 males, 105 females) from San Diego County, California.
- (C1) *Crotalus viridis viridis* (342 males, 331 females) from the vicinity of Pierre, South Dakota; and (C2) the same subspecies (441 males, 392 females) from near Platteville, Colorado.
- (D1) *Crotalus viridis viridis* (68 males, 37 females) from north-central New Mexico; and (D2) *Crotalus viridis nuntius* (69 males, 39 females) from the immediate vicinity of Winslow, Arizona.
- (E1) *Crotalus viridis oreganus* (326 males, 289 females) from near Pateros, Washington; and (E2) the same subspecies (318 males, 320 females) from San Diego County, California.
- (F1) *Crotalus cerastes* (49 males, 47 females) from eastern San Diego County; and the same species (24 males, 21 females) from transmontane Los Angeles County, California.

The symbols (A1, etc.) have been assigned to the series to facilitate tabulation. The numbers of the specimens give an indication of the probable reliability of the means and coefficients. It should be noted that the labials involve two counts per specimen.

¹ The coefficient of variation is defined as the standard deviation divided by the mean; the coefficient of divergence as the difference between a pair of means divided by half their sum. Both coefficients are independent of the scale of measurement and thus place diverse characters on a comparable basis.

TABLE I
COEFFICIENTS OF VARIATION WITHIN GROUPS
(in per cent)

Character	Population Group																	
	A1	A2	Mean	B1	B2	Mean	C1	C2	Mean	D1	D2	Mean	E1	E2	Mean	F1	F2	Mean
Scale rows	3.75	2.90	3.32	3.62	2.99	3.30	3.85	3.80	3.82	3.82	3.85	4.31	4.08	3.48	3.42	3.45	4.07	4.18
Ventrals, male	1.56	1.68		1.61	1.73		1.77	1.72		1.82	1.91		1.92	1.80		1.57	1.89	
Ventrals, female	1.37	1.72		2.27	1.81		1.80	1.73		2.15	1.69		1.84	2.01		2.30	2.11	
mean	1.47	1.70	1.58	1.94	1.77	1.85	1.79	1.73	1.76	1.98	1.80	1.89	1.88	1.91	1.89	1.94	2.00	1.97
Subcaudals, male	5.32	4.99		5.14	6.42		5.28	5.74		6.37	5.26		6.27	6.29		7.31	4.61	
Subcaudals, female	8.40	7.62		6.38	9.88		7.21	7.31		8.00	8.04		8.62	7.66		9.38	5.59	
mean	6.86	6.31	6.58	5.76	8.15	6.95	6.24	6.52	6.38	7.19	6.65	6.92	7.44	6.97	7.21	8.35	5.10	6.72
Supralabials	5.99	5.42		5.70	5.93		5.82	6.11	6.05	6.08	6.96	6.07	6.51	5.94	5.46	5.70	6.47	5.25
Infralabials	5.46	6.00		5.73	5.93		5.59	6.32	6.35	6.35	7.05	6.13	6.59	6.03	5.51	5.77	6.49	6.28
Body blotches	6.13	6.25		6.19	6.92		7.35	8.04	7.69	7.86	8.75	8.30	6.99	6.90	6.94	7.84	7.50	7.67
Tail rings, male	16.05	11.63		12.86	15.38		12.99	12.70		13.43	12.83		17.52	14.09		15.97	14.67	
Tail rings, female	23.03	13.82		13.07	17.23		15.17	13.35		17.78	12.66		18.04	14.88		22.57	24.76	
mean	19.54	12.73	16.13	12.96	16.30	14.63	14.08	13.02	13.55	15.61	12.75	14.18	17.78	14.49	16.14	19.27	19.72	19.49

The coefficients of variation are given in Table I; the coefficients of divergence between pairs in Table II.

From Table I, it will be seen that certain character trends in variability are evident, that is, some characters are definitely more variable than others. Thus, there is enough character fluctuation to test the questioned correlation. There are some rather wide sexual differences in variability within a series, this being particularly true of subcaudals and tail rings; the females usually have a higher variability than the males.

TABLE II
COEFFICIENTS OF DIVERGENCE BETWEEN GROUPS
(in per cent)

Character	Pair of Groups					
	A	B	C	D	E	F
Scale rows	4.70	4.90	0.19	6.34	0.24	4.33
Ventrals, male	4.00	3.77	1.18	0.62	0.04	4.70
female	4.33	2.36	0.95	1.65	0.01	4.92
mean	4.16	3.06	1.06	1.13	0.02	4.81
Subcaudals, male	1.00	0.43	0.23	3.64	4.31	1.87
female	3.08	2.90	1.34	7.86	3.14	2.04
mean	2.04	1.66	0.78	5.75	3.72	1.95
Supralabials	0.96	0.06	0.88	0.01	0.33	1.76
Infralabials	6.55	2.04	0.32	3.47	0.93	1.91
Body blotches	1.57	20.20	2.69	3.90	5.62	2.12
Tail rings, male	24.00	2.74	4.56	0.64	25.25	1.89
female	15.90	0.00	1.21	2.09	30.40	8.96
mean	19.95	1.37	2.88	1.36	27.82	5.42

Table II shows a considerable variation in the extent of character divergence between the members of the several pairs. Outstanding divergences are noted in the tail rings of the *cinereous* and *oreganus* pairs, and in the body blotches of the *lucasensis-ruber* pair.

The results of the correlation tests are shown in Table III. It will be observed that only one pair out of six (*oreganus*) shows a significant correlation, although two others closely approach the usually accepted 5 per cent level; these are *cinereous* and *viridis viridis*. The high value of the correlation coefficient in the *oreganus* pair results largely from the fact that the most variable character (tail rings) also shows a high divergence between the two populations. If we eliminate this character the remaining six have a much-reduced correlation ($r = .743$, $P = .09$).

TABLE III
COEFFICIENTS OF CORRELATION AND MEAN DIVERGENCE BETWEEN PAIRS
(in per cent)

Pair of Groups	Coefficient of Correlation	Signifi- cance	Mean
			Divergence, Per Cent
A. California and Texas <i>cinereous</i>	.733	.061	5.70
C. Pierre and Platteville <i>viridis</i>	.721	.067	1.26
B. Cape <i>lucasensis</i> and San Diego County <i>ruber</i>	-.047	.92	4.76
E. Pateros and San Diego County <i>oreganus</i>	.954	.0009	5.52
D. New Mexico <i>viridis</i> and Winslow <i>nuntius</i>	-.117	.80	3.14
F. San Diego County and Los Angeles County <i>cerastes</i>	.345	.45	3.19

In Table III I have also set forth the average of the seven coefficients of divergence for each pair. This may be taken as a rough indication of the

closeness of relationship between the members of the pairs, insofar as shown by these particular characters. The closest relationship seems to be between the two series of *viridis*, while the greatest difference is between the Texas and California groups of *cineareus*.

If we combine the correlation coefficients of the six pairs, using a method given by Tippet (1937: 177), we find that a significant correlation is evident ($P = .002$). If we omit the *oreganus* pair P is increased to .20.

Another method of combining the results to give a single figure representing all the pairs, is to consider all the values as components of a single correlation table. By this means we find the value of r to be .420, which is significant ($P = .006$). The 5 per cent confidence limits or r are .133 to .642. Thus we may conclude that in these rattlesnakes the factors or forces which produce territorial modifications are somewhat dependent in their effectiveness on the inherent variability of the characters upon which they operate, being more effective on those characters which tend to show a high variability within a territorially homogeneous series. However, this correlation is by no means close. Of the particular characters considered, the number of tail rings, the most variable character, sometimes shows an unusually high divergence as well, thus having an important bearing on the extent of the correlation.

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Food of the Basilisk Lizard in Panama

By ALBERT BARDEN

FIELD observations on basilisks (*Basiliscus basiliscus* Linnaeus) at Barro Colorado Island, Canal Zone, Panama, during July and August of 1938, yielded disappointingly little information about the food of this species. Contradictory statements concerning the nature of the food appear in the literature and indicate that few studies based on stomach analyses have been made for the basilisk. Hallinan (1920) reported finding Lepidoptera, Coleoptera, Odonata, Orthoptera, a fish, and some fruit in the stomachs of three specimens. Park (1938) found grasshoppers in the stomachs of two immature specimens.

I am indebted to Mr. Karl P. Schmidt for permission to examine the stomach contents of *Basiliscus basiliscus* in the Field Museum's collections, and to Dr. Orlando Park for permission to examine specimens in the collections of Northwestern University. Dr. Park was of constant assistance in the determination of the material, particularly the Coleoptera; Dr. Neal A. Weber identified the ants, and a number of specialists have helped in identification of items of other groups.

A total of 106 specimens of *Basiliscus basiliscus* was examined. Most of these (101) had been collected in Panama, largely in the Canal Zone; five were from Costa Rica. Seven specimens had empty stomachs, leaving ninety-nine that contained food. Vegetable matter comprised about 22 percent of the total volume of food, animal material 78 percent. The vegetable material included fruit, berries, nuts, flowers, leaves, twigs, moss, grass, sedges, fungi and charcoal, much of it fragmentary and probably taken by accident. However, the fruiting spadix of *Anthurium*, an aroid, and various berries were certainly taken by design, for they occurred in considerable numbers in some stomachs. Vegetable matter constituted the sole food in one stomach; it consisted of twenty-two berries, each the size of a small pea. Varying amounts of vegetable matter were present in fifty stomachs.

Animal food was found in ninety-eight stomachs. A systematic list of the animal food with numerical percentages and the number of stomachs in which each food item was found, follows.

Food item	Numerical percentage	Number of stomachs in which found
Mollusca (0.44%)		
Gastropoda (snails)	0.44	5
Arthropoda		
Undetermined Arthropoda	0.09	1
Crustacea (2.54%)		
Isopoda		
Oniscoidea (sow bugs)	0.35	3
Undetermined Isopoda	0.79	8
Decapoda		
Crabs	0.35	1
Shrimps	1.05	3
Chilopoda (0.44%)		
Geophilidae (centipedes)	0.26	2
Undetermined Chilopoda	0.18	2
Diplopoda (0.53%)		
Undetermined Diplopoda (millipedes)	0.53	6
Insecta (87.85%)		
Collembola		
Arthropleona (springtails)	0.09	1
Orthoptera (4.82%)		
Blattidae (roaches)	0.61	5
Gryllidae (crickets)	1.05	7
Locustidae (short-horned grasshoppers)	0.79	7
Tettigoniidae (long-horned grasshoppers)	0.26	3
Undetermined Orthoptera	2.11	20
Isoptera (termites)	0.88	1
Neuroptera (ant-lions, aphid-lions)	0.70	3
Odonata (0.61%)		
Anisoptera (dragonflies)	0.26	2
Undetermined Odonata	0.35	4
Thysanoptera (thrips)	0.18	2
Heteroptera (6.15%)		
Gelastocoridae (toad bugs)	0.53	6
Cydnidae (burrowing bugs)	1.67	1
Lygaeidae (chinch bugs)	0.09	1
Nepidae (water-scorpions)	0.35	2

Food item	Numerical percentage	Number of stomachs in which found
Pentatomidae (stink bugs)	0.26	3
Reduviidae (assassin bugs)	0.09	1
Undetermined Heteroptera	3.16	26
Homoptera (0.71%)		
Cercopidae (spittle insects)	0.09	1
Fulgoridae (lantern-flies)	0.09	1
Membracidae (tree-hoppers)	0.09	1
Undetermined Homoptera	0.44	5
Dermaptera (earwigs)	0.09	1
Coleoptera (19.86%)		
Anthicidae	0.09	1
Bruchidae	0.09	1
Carabidae (ground beetles)	2.89	15
Bembidiini	0.35	2
Cerambycidae (long-horned beetles)	1.32	11
Chrysomelidae (leaf beetles)	1.23	9
Curculionidae (weevils)	0.96	11
Colydiidae	0.09	1
Elateridae (click beetles)	0.44	2
Gyrinidae (whirligig beetles)	1.67	1
Passalidae	0.09	1
Pedilidae	0.09	1
Platypodidae	0.88	1
Prionidae	0.09	1
Scarabaeidae		
Dung beetles	0.18	1
Leaf chafers	0.09	1
Undetermined Scarabaeidae	1.14	5
Silphidae (carrion beetles)	0.44	2
Sinodendridae	0.09	1
Staphylinidae (rove beetles)		
Paederinae	0.09	1
Undetermined Staphylinidae	0.88	7
Tenebrionidae (darkling beetles)	0.09	1
Undetermined Coleoptera	6.58	31
Trichoptera (caddis flies)	0.26	3
Lepidoptera (9.29%)		
Heterocera (moths)	0.70	8
Rhopalocera (butterflies)	0.70	6
Undetermined Lepidoptera	7.89	34
Diptera (7.81%)		
Mycetophilidae (fungus gnats)	0.09	1
Stratiomyidae (soldier flies)	0.18	2
Undetermined Diptera	7.54	40
Hymenoptera (35.61%)		
Wasps	4.65	27
Ichneumonidae (parasitic wasps)	0.61	5
Bees	3.42	21
Formicidae (ants)	26.14	68
Undetermined Hymenoptera	0.79	6
Arachnida (7.20%)		
Pedipalpi	0.44	2
Araneida (5.71%)		
Attidae (jumping spiders)	0.18	1
Clubionidae	0.09	1

Food item	Numerical percentage	Number of stomachs in which found
Undetermined Araneida	5.44	42
Phalangida (daddy-long-legs)	0.09	1
Acarina (ticks and mites)	0.96	10
Vertebrata (0.97%)		
Undetermined Vertebrata	0.26	3
Pisces (fishes)	0.09	1
Amphibia (frogs)	0.18	2
Reptilia (lizards)	0.26	3
Aves (birds)		
Tyrannidae (flycatchers)	0.09	1
Undetermined bird	0.09	1

The animal food, consisting of 1141 separate items, was about 99 percent invertebrate and 1 percent vertebrate. The absence of mammals may be due to the basilisk's diurnal habits. The fish and possibly the frog remains indicate that the basilisk secures part of its food from the water. This conclusion is borne out by the invertebrate food. The crabs, shrimps, water-scorpions and whirligig beetles are aquatic and several of the other food items, like the toad bugs, are usually found near the water.

The Lepidoptera found were mainly larvae.

The gyrid beetles were identified by Dr. Georg Ochs as *Gyretes centralis* Regimbart, a specie that was described in 1907 from a single specimen from San Mateo, Costa Rica, and had not since been recorded.

Ants were numerically the most important single kind of food, comprising over 26 percent of the animal material. Williams (1941) found that ants made up 22 to 27 percent of the forest floor fauna at Barro Colorado; obviously the basilisk eats abundantly of abundant food. Dr. Weber identified the ants as follows: *Atta*, *Azteca*, *Camponotus*, *Cephalotes*, *Crematogaster*, *Cryptocerus*, *Dolichoderus*, *Ectatomma*, *Gnamptogenys*, *Leptogenys*, *Monomorium*, *Neoponera*, *Odontomachus*, *Pachycondyla*, *Paraponera*, *Pheidole*, *Pseudomyrma*, *Sericomyrmex* and *Solenopsis*. A few were identifiable to species: *Atta colombica*, *Ectatomma tuberculatum*, *Paraponera clavata* and *Sericomyrmex amabilis*. Since some of these ants are strictly arboreal, it seems probable that the basilisk obtains part of its food while in the trees.

It may be stated that the wide variety of food taken (at least 29 orders of animals) indicates that the basilisk eats virtually all animal food available in its habitat, supplementing it with a variety of vegetable food.

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PROVIDENCE, RHODE ISLAND.

Herpetological Notes

A CASE OF EXTERNAL HERNIA IN *HYLA AUREA*.—The present record of external hernia in *Hyla aurea* Lesson is unique so far as I have been able to ascertain. Teratomas and variations have been reported for several species of frogs, but the majority of such accounts deal with anomalies of the vascular system, although an extensive literature has developed in connection with natural and artificially induced chimaeras. Osborne (Proc. Roy. Soc. Victoria, 31) and Benham (Trans. N. Z. Inst., 51: 30) have recorded variations in the vascular system of the present species, which is commonly dissected in teaching laboratories in Australia and New Zealand. Similar variations have been recorded for *Rana pipiens* and *R. catesbeiana*, but the number of anomalies recorded for the various laboratory species is remarkably small in consideration of the vast amount of material examined annually.

Among the frogs sent to the Biology Department of Victoria University College this spring for preservation, a female specimen was found with a soft elliptical swelling 2.0 cm. long by 1.25 cm. wide over the sacral region. On reflecting the skin it was seen that an external rupture of the uterine portion of the oviduct had taken place through the body wall into the dorsal lymph space. The extruded portion of the oviduct was covered externally by a thin, strong, highly vascularised membrane which was continuous with the dorsal aponeurosis; and a thinner, weaker membrane later found to be continuous with the peritoneum. The rupture had taken place through an aperture 4 mm. long immediately lateral to the left ilium and extending between the tip of the transverse process of the sacral vertebra and the origin of the *M. gluteus*. The boundaries of the rupture were the posterior border of the muscular portion of the *M. obliquus externus* anteriorly and laterally, the head of the *M. gluteus* and the lateral face of the ilium medially. The extruded portion of the oviduct had pushed ahead of itself a portion of the peritoneum and had carried along its own mesentery and mesenteric vessels. There was no indication of strangulation, but multiple peritoneal adhesions had developed and bound the extruded portion of the oviduct into a compact mass which probably could not have become self-reduced.

The specimen was not gravid, but the oviducts and ovisacs had already undergone considerable preliminary hypertrophy. Other females in the collection were already gravid, and some kept alive for the purpose spawned three days after arrival at the laboratory. The ovaries and oviducts in this specimen were symmetrically developed. Both oviducts, when unravelled, were of the same length (30 cm.). This would preclude the possibility that the rupture had resulted from exceptional unilateral local hypertrophy, and would strongly suggest that it had occurred during the normal hypertrophy of the oviduct in preparation for the reception of eggs. It is remarkable that the rupture should have occurred in the present manner. It is reasonable to consider that the oviduct during its increase in size might split its mesentery to the root and then continue through the body-wall. This clearly did not take place, since the mesentery had its normal relationship with the extruded portion of the oviduct and also a portion of the peritoneum had been carried out ahead of the oviduct. In view of the relationship of the oviduct and the body-wall, this would preclude the possibility that the rupture had followed from a failure of the mesenteries, and the remaining possibility is that an adhesion of the oviduct to the body-wall prior to hypertrophy had fastened down this portion of the oviduct and forced its development through the body-wall. If the latter is the case, as seems most reasonable, the origin of the rupture probably dates from the previous spawning, or less probably might be congenital.

Hernias are apparently uncommon in the cold blooded vertebrates, though Hoheisel (1932, Trans. Ill. Acad. Sci., 24: 222) claims that hernia is fairly common in *Necturus*, and describes three cases of abdominal hernia in that salamander.

The present case is of interest in view of the peculiar nature of the hernia which would not be liable to influence the survival of the animal outside of the mating season. The edges of the perforation through the body-wall were firm and it is highly improbable that a normal oviposition could have proceeded on this side.—LAURENCE R. RICHARDSON, Victoria University College, Wellington, New Zealand.

REMARKS ON SOUTH AMERICAN FOSSIL CROCODILES.— A gigantic, relatively long-jawed crocodilian from Colombia has recently been described by Dr. Charles C. Mook as a new species of *Dinosuchus* Gervais, *D. neivensis* (1941, Proc. U.S. Nat. Mus., 91: 55). The horizon is tentatively considered to be early Cretaceous on invertebrate evidence from nearby localities. Mook bases his generic assignment on the vertebrae of his specimen which "... correspond in general character and somewhat in size with the vertebra described by Gervais as *Dinosuchus terror*," on his belief that the short-jawed *Brachygnathosuchus*, from Amazonas, Brazil, is not synonymous either with *Dinosuchus* or with *Purussaurus*, both also from Amazonas, and on Gervais' guess that the type of *D. terror* may have come from early Tertiary or late Cretaceous deposits. He states that Nopcsa (1924, Ctbl. Min. Geol. Pal., 1924: 378) did not place *Brachygnathosuchus* in the synonymy of *Dinosuchus*.

I am unable to follow Dr. Mook in his insistence that *Brachygnathosuchus* is distinct from *Dinosuchus*, in his assertion that *Dinosuchus* is of Cretaceous age, or in his reference of *neivensis* to this genus.

In the first place Nopcsa did not consider *Brachygnathosuchus* and *Dinosuchus* to be distinct. He believed that the former was synonymous with *Purussaurus* which he in turn relegated to *Dinosuchus*: "Die *Dinosuchus*—Wirbel sind mit den Wirbeln von *Brachygnathosuchus* = *Purussaurus* [sic] fast sicher ident, . . . daher hat auch der Genusname *Purussaurus* zu fallen." In my summary of the South American Cenozoic crocodiles (1936, Herpetologica, 1: 43-54) I suggested that *Purussaurus* and *Brachygnathosuchus* were not synonymous, but concluded that on the available evidence there was no alternative to relegating the latter to the synonymy of *Dinosuchus*. Nopcsa's remark that the vertebrae of the two are "fast sicher ident" is by no means too strong a statement. Mook ignores this positive similarity, yet bases his generic assignment of *neivensis* on the less exact resemblance between the vertebrae of this form and of *D. terror*.

As stated by Mook, there is presumptive evidence that *neivensis* is a Cretaceous form. There is on the contrary no good evidence that the type of *D. terror* came from deposits of this age, and rather strong evidence that it is a late Tertiary, probably late Miocene, form, hence of the same age as "*Brachygnathosuchus*." Gervais' tentative opinion that the specimen came from late Cretaceous or early Tertiary deposits (1876, Journ. Zool., 5: 233) is quite worthless since at that time almost nothing was known of the geology of Amazonas. It may be remarked in passing, however, that his account of the preservation of the specimen agrees rather closely with that given by Rodrigues (1892, Contr. Mus. Bot. Amazonas, 2: 51, 52) for the type of *Purussaurus brasiliensis*, a form which Mook regards as late Tertiary. Within the last twenty years the geological reconnaissances of Singewald in eastern Peru and of Oppenheim in the south-western part of Amazonas Province have shown that the rock succession, at least in its major features, is remarkably uniform throughout this vast region. The details are reviewed elsewhere by me in another connection (1942, Amer. Mus. Novit., No. 1173: 5 ff.), and it will only be necessary here to mention the upper units in the succession which have a bearing on the age of the crocodilians that have been found in Amazonas. These are the "Red Beds" and the "Brown Beds" series. Deposition of the former extended from late Cretaceous to late Tertiary (Miocene or Pliocene), as determined by invertebrates identified by Pilsbry. At Aquidabam on the middle Jurua, Oppenheim found crocodilian remains in deposits immediately overlying the Red Beds series, evidently therefore at the base of the Brown Beds. These were determined by Roxo (1937, Minist. Agric. [Brazil] Serv. Geol. Min. Not. prelim. estud. no. 9: 4; no. 14: 10) as *Caiman*?, *Gryposuchus* and *Dinosuchus* (= *Brachygnathosuchus*). In view of the geologic uniformity alluded to above, it is highly probable that all the Amazonas crocodilians have come from the same or from a nearly equivalent horizon. A fossil rodent found with "*Brachygnathosuchus*" is referable to *Phoberomys*, a genus found elsewhere only in the late Miocene Mesopotamian of Argentina, a horizon which also contains numerous crocodilians, some of them of gigantic size. This positive suggestion that deposition of the Brown Beds series began in late Miocene time agrees well with the upper age limit assigned to the Red Beds series by Pilsbry's determinations. Further supporting evidence is also provided by the toxodont *Trigodonops lopesi* from the upper Jurua (Kraglievich, 1932, Rev. Soc. Amigos Arqueol., 5: 195 ff.) which also suggests, although less certainly than *Phoberomys*, Mesopotamian age.

On the basis of the available geologic evidence the only reasonable supposition is that both *Dinosuchus terror* and "*Brachygnathosuchus brasiliensis*" are of the same late Miocene age. The practical identity between the dorsal vertebrae of the two specimens leaves no present alternative to placing the short-jawed "*Brachygnathosuchus*" in the synonymy of *Dinosuchus*. The reference of a long-jawed, possibly early Cretaceous, Colombian crocodilian to *Dinosuchus* therefore seems to be definitely erroneous.

The existence in the literature of a statement that Cretaceous deposits occur on the Rio Aquiry, a southern tributary of the Purús, requires consideration in this connection. Agassiz (in Agassiz and Agassiz, "A Journey in Brazil," 1867: 409) stated that he had identified *Mosasauros* and fishes closely allied to those occurring in the Maestrichtian among material collected on this river by Chandless. This has been repeated by various authors (Chandless, 1866, J. Roy. Geog. Soc., 36: 119; Hartt, "Geology and Physical Geography of Brazil," 1870: 494, 556; White, 1887, Arch. Mus. Nac. Rio de Janeiro, 7: 9; Williston, 1898, Univ. Geol. Surv. Kansas, 4: 89; Kuhn, 1939, Fossilium Catalogus, pars. 86: 81). Despite Agassiz's authority, I doubt the correctness of the identifications. No description of the collection was ever published. According to Chandless, the supposed mosasaur remains consisted of "two vertebrae in perfect preservation"; no statement as to the nature and number of the fish specimens has been made. In view of the fact that the material was found loose and not *in situ*, it is very probable that the vertebrae consisted merely of centra and that the fish remains were equally fragmentary. Agassiz made the determinations in Manaus, certainly without benefit of comparative material and almost surely without the aid of literature. Under such circumstances identification of fish fragments would be attended by the greatest uncertainty, and it would be entirely possible to mistake a crocodilian centrum for that of a mosasaur, particularly since the presence in Amazonas of gigantic fossil crocodilians comparable in size to the largest mosasaurs was not then known: I strongly suspect that the vertebrae were in fact crocodilian, and that the collection came from the late Miocene deposits that have yielded similar remains in other parts of Amazonas. This is supported by Chandless' statement that his Aquiry material was derived from the same type of rock ("pseudo-conglomerate") which yielded fossil bones and wood in the upper part of the Purús. His account of the preservation of these Purús specimens (*loc. cit.*; 98) agrees with that given by Rodrigues for *Purussaurus* and by Gervais for *Dinosuchus*. The Chandless collection is unfortunately lost. Although presented to Agassiz, Professor Romer informs me that it is not now to be found in the Museum of Comparative Zoology.

Mook recognizes *Purussaurus* as distinct from although closely related to *Caiman*. In 1936 (*op. cit.*) I tentatively referred this form to *Caiman*, since, despite the enormous size of *P. brasiliensis*, the inadequate description and figures revealed no positive generic differences between the two (the much larger size of the first mandibular alveolus in the fossil is quite possibly due to breakage). The genus may well prove to be valid when better known, but it seemed to me then, and still does, that a conservative course is best until sufficient material is available to place the taxonomy of the Neotropical Tertiary Crocodilia on a sound basis. The erection in the past of genera and species founded on fragments of unknown age has caused considerable confusion in the literature which is only beginning to be cleared up. It is unfortunate that in "*Dinosuchus neivensis*" we are presented at this late date with another fragmentary type of uncertain age and dubious affinities.

I take this opportunity to correct a printer's omission in my 1936 paper. On page 53 the genus *Rhampathomopsis* should have been preceded by the heading "Gavialidae."—BRYAN PATTERSON, Field Museum of Natural History, Chicago, Illinois.

A SEMI-ALBINO MILK SNAKE IN MASSACHUSETTS.—On November 20, 1940, a young, semi-albino milk snake was taken in Hingham, Massachusetts, by Mr. W. D. Thomas. This snake measured 225 mm. The pattern was the normal milk snake design but the color of the patches on the back was a shade between Carnelian Red and Carrot Red (Ridgway's *Color Standards*). The scales between the patches were a slightly cloudy, or milky, white. The patches on the side (normally of about the same color as those on the back) were a light grey, slightly suffused with the same shade as that of the dorsal saddles. The eyes were pink as in a true albino. The little snake lived for

about two months in captivity, during which time it took no food. It is now in the study collection of the Boston Society of Natural History (No. 1655). A color sketch was made by John Patterson, the museum preparator.—ISABEL HOOPES, *Boston Society of Natural History, Boston, Massachusetts.*

NOTES ON *RHYACOTRITON OLYMPICUS* AND *ASCAPHUS TRUEI* IN HUMBOLDT COUNTY, CALIFORNIA.—To my knowledge, the Olympic salamander, *Rhyacotriton olympicus* (Gaike), has been found only once south of the Rogue River, southwestern Oregon. Wood (COPELAND, 1939: 110) mentions three examples from Wilson Creek, north of Klamath, Del Norte County, California. Three larvae from central Humboldt County, about 50 miles south of Wilson Creek, add to these records.

During a brief automobile trip in July, 1941, Mrs. Myers and I stopped at a tiny brook along the Arcata-Weaverville road (U. S. Highway 299), 1.2 miles (by road) west of the boundary sign of Trinity National Forest and 2.2 miles (by road) west of the bridge over the east fork of Willow Creek. At this point the road runs high up on the north slope of Indian Butte, and crosses many small springs and seepages flowing down the steep slope into Willow Creek of the Trinity River system. The brook must be one of the several small unnamed watercourses shown between Ruby and Cedar creeks on the U. S. Forestry Service topographic map of Trinity National Forest. The stream issues at the road from a deep, narrow defile (20 to 40 feet wide at most), shaded by its high walls and by tall cedars (*Chamaecyparis wilsoniana*). The locality is far enough inland to be outside the coastal redwood belt. The very cold water cascades downward over a series of boulders covered with thick moss, kept green and dripping by the spray. All three larvae were discovered by Mrs. Myers by gently moving small stones, 3 or 4 inches in diameter, in the quietest part of the stream close to the road, hiding under the stones in 2 to 4 inches of water.

I was surprised to find no *Dicamptodon* larvae in the stream, since *Dicamptodon* is ubiquitous in running water in the wooded northern coastal region of the state. Active search for *Rhyacotriton* in other places, where *Dicamptodon* was present, uncovered no others. After collecting adult and larval *Rhyacotriton* along the Rogue River¹ I had believed that it was to be found in rock-slide seepages, but the several shaly seepages along U. S. 299 near the stream in which we found them in California were barren.

Rhyacotriton larvae are very similar in appearance to small larval *Dicamptodon*, and may easily be mistaken for them in the field, but they differ in a number of ways. The snout is much shorter in *Rhyacotriton* and the end much rounder and less bluntly shovel-shaped than that of *Dicamptodon* when viewed from above, though in side view the muzzle of the smaller form is much blunter and more bulldog-like. The shallow groove that runs upward and backward from each nostril of *Rhyacotriton* is not evident in *Dicamptodon*. The lips of the two genera are distinctive. In *Dicamptodon* a wide median frenum separates the two sides of the lower lip, while in *Rhyacotriton* this frenum is only half as wide. Perhaps the most striking difference in color is the bold, irregular, smoky-dark-and-light mottling or marbling of the dorsal-caudal fin of *Dicamptodon*, which never appears in the other genus. *Rhyacotriton* is speckled, under the brown ground color of the dorsum, with irregular black dots, while the variegation of the duller, more grayish dorsum of *Dicamptodon* is caused entirely by irregular small light areas. I have never seen a *Dicamptodon* larvae with any markings on the clear whitish venter, but the yellow under surface of *Rhyacotriton* almost always has a sprinkling of at least a few dark flecks.

The best recognition character for larval *Rhyacotriton* lies in the appearance of the eyes and their position in relation to the short snout. The eyes are directed more dorsally than those of *Dicamptodon* of like size, and the peculiar configuration of the snout makes them seem to be pointed more anteriorly. They appear very round and staring, and somewhat "crossed" when viewed from the front. These peculiar eyes recall those of the larval *Leurognathus* figured by Dunn in 1917 (*Bull. Amer. Mus. Nat. Hist.*, 37: 612, pl. 59), though in *Rhyacotriton* the wide iris is not white. Upon metamorphosis, of course, the head shape and the eyes change radically.

The specimens above mentioned are in the Stanford Natural History Museum (6402—

¹ Ravine about two miles west of Lobster Creek, on the north shore of the Rogue River, near its mouth. Specimens in Stanford collection.

6404). They are 49.5, 48, and 28.5 mm. in length. The two smaller ones were collected on July 15, and the largest, which has almost lost the external gills, was obtained at the same place next day.

During the same trip, on July 14 and 15, 1941, we examined for the third time the small brook north of Dyerville, Humboldt County, from which I recorded *Ascapthus truei* ten years ago (COPEIA, 1931: 56). The *Ascapthus* tadpoles were there, as they were in 1930 and 1939. On the recent trip we made an effort to find tadpoles or adults in all the similar small brooks or larger creeks which cross the Redwood Highway nearby, from Dyerville to Pepperwood, as well as in the Bull Creek Redwood Grove, without success. Apparently only this one small stream, out of the many in this section, harbors *Ascapthus*, and the past ten years of collecting has not produced a more southerly record.

The *Ascapthus* stream has changed somewhat in ten years. The road has been rebuilt and there is no longer an "alga-grown section at the highway." Tourists and picnickers may now turn off and park their automobiles in a tramped-down area of some extent under the giant redwoods on the south side of the stream near the road, but the little brook is still scarcely to be noticed as one drives by on the highway. (The bridge over Chad Creek, exactly one mile south, which I mentioned as a landmark, is now not recognizable as a bridge when one crosses it.)

We turned almost every stone, in the water and out, for a distance of 200 feet, in the effort to find adults. We also searched at night, and next day ascended some 300 feet further (as far as we were able in a well-nigh impenetrable tangle of brush, ferns, poison oak and fallen trees) to a point above the junction of the two forks that form the brook. Tadpoles were seen as high as we went, but not a sign of an adult. *Dicamptodon* larvae and *Rana boylei boylii* were as abundant as usual.

The tadpoles were at approximately the same stage of development as those taken on June 22, 1930 (which are now in the U. S. National Museum). They have short hind legs. The black caudal area and milk-white tail-tip are prominent in most of the individuals.

I watched one tadpole feeding on a stone over which the swiftest current in a riffle was falling. He moved about readily when he desired, a millimeter or two at a time, by a slight "inching along" movement of the adhesive mouthparts. He would turn this way and that, his tail fluttering and flapping downstream in the current, and the slight but constant movement of his mouthparts indicated that he was scraping at the surface of the rock. Although nothing could be seen on the stone, there was probably a growth of minute algae. At times the tadpole was almost half out of water, and again he would browse along till he was nearly on the under side of the stone. All of the tadpoles seen were in the swiftest current available, usually on the side of a stone where a drop of a couple of inches formed a riffle.

The stream with *Ascapthus* tadpoles seems to have no name. It is shown on the official county map of Humboldt County as about a mile long from its sources to its mouth at the Eel River. Lumbering operations, which affect water temperature in such creeks, steadily approach the privately owned area in which *Ascapthus* Creek is located, and this southernmost locality for *Ascapthus* may not long exist, unless it is soon added to the nearby state-owned groves.—GEORGE S. MYERS, *Stanford University, California*.

A RECORD OF THE CAVE SALAMANDER FROM ALABAMA.—While searching a small limestone cave along the shore line of Wilson Reservoir, October 2, 1942, for *Anopheles quadrimaculatus* mosquitoes, two specimens of the cave salamander *Eurycea lucifuga* Rafinesque were collected by Lieutenant John Belkin and myself. The cave is located on the north-west side of the Wheeler Dam Access Road Bridge (Highway 20) where it crosses the Big Nance Creek arm of Wilson Reservoir, between Town Creek and Leighton, Colbert County, Alabama.

Dunn states that the Museum of Comparative Zoology at Harvard has a single specimen from an unnamed locality in Alabama. The new record, therefore, definitely fixes a locality in Alabama, and is incidentally the southernmost station known for this interesting cave salamander. The identification was confirmed by Professor A. H. Wright of the Cornell University, and the specimens are now in the permanent collection of that institution.—CAPTAIN WOODROW W. MIDDLEKAUFF, *Sanitary Corps, Fourth Service Command Laboratory, Fort McPherson, Georgia*.

NORTHWARD EXTENSIONS OF THE RANGE OF *ASCAPHUS*.—Ricker and Logier (COPELA, 1935: 46) reported the discovery of *Ascaphus truei* Stejneger in streams about Cultus Lake, in southwestern British Columbia, and this appears to have been the only published Canadian record for the species. Cultus Lake is situated on the western edge of the Cascade Mountain system about 4 miles north of the international boundary, and roughly 15 to 25 miles northwest of the localities in the Mount Baker region recorded by Wright and Wright (Handbook of frogs and toads, 1933: 36) and Svihla (COPELA, 1933: 39).

On June 20, 1941, two rather small specimens, a male, 28.5 mm., and a female, 27.8 mm., in length were taken in British Columbia by the senior author from a small stream descending the steep eastern slope of the Fraser River Valley approximately 15 miles south along highway A from Lytton (elev. 565 ft.). One was found in an undercut at the foot of a small waterfall, the other in gravel at the edge of a riffle. The plant cover of the surrounding area was of a more xeric nature than that with which *Ascaphus* is usually associated, being transitional in character between the coastal and interior forest types as mapped and described by Whitford and Craig (Forests of British Columbia, 1918, Ottawa), and zonally referable to the semiarid division of the Transition Zone as described by Bailey (North American Fauna No. 55, 1936). This locality is about 105 miles north and east of the Cultus Lake station.

A record of *Ascaphus truei* near Hatzic, British Columbia, extends the known range of the species northwestward about 15 miles through the humid Coastal Belt to a point on the north side of the lower Fraser River Valley 35 miles east of Vancouver. The specimen (Prov. Mus. 634) upon which this record is based is an adult male 43.0 mm. in length, collected September 5, 1941, by Mr. Kenneth Graham of the Science Service, Dominion Department of Agriculture, at an elevation of 2300 feet and at a point about 5 miles northwest of Hatzic, in Cascade Creek. The specimen was carried about until September 15, when it was delivered to the Provincial Museum at Victoria. There it was placed in a small vivarium, and at the time of writing (February, 1942) is still living.

An expectant search for *Ascaphus* in suitable streams of the Interior Wet and Rocky Mountain Belts of British Columbia and Alberta was carried on by the senior author and Miss Myra G. Willis in July and August, 1941, in the course of a University of Washington botanical field trip through southwestern Canada. Although conditions seemingly ideal for this amphibian were met with, *Ascaphus* was not again encountered until Glacier National Park, Montana, was reached on August 10. There an adult female (length 40.8 mm.) and five larvae (30.5 to 50.0 mm. long) were taken at an elevation of 3160 feet from a small stream flowing through a dense stand of cedar and hemlock to the southeastern shore of McDonald Lake. Previous records for the park and vicinity recorded by Wright and Wright (*op. cit.*) and Donaldson (COPELA, 1934: 184) mark the extreme northeastern corner of the known range.—JOHN W. SLIPP, Tacoma, Washington, and G. CLIFFORD CARL, Provincial Museum, Victoria, British Columbia.

ERYTHRISTIC SPECIMENS OF *THAMNOPHIS RADIX*.—Individual variations in color and pattern are quite common in the Plains garter snake, *Thamnophis radix radix*. Although this species is frequently marked with flecks of red distributed indiscriminately, red pigmentation to the extent seen in *Thamnophis sirtalis parietalis* is quite rare. Use of garter snakes for experimental purposes in this laboratory made it possible to examine 1,450 specimens, 750 in 1938 and 700 in 1941. One erythristic specimen was found in each of these two large groups, and one specimen was taken in the field in 1941. All 1,450 specimens were *T. r. radix* although this region is well within the range of *T. s. sirtalis*. The red color in these three specimens is found on the scales between the rows of normal dark spots along the sides and back. In places, the red encroaches on the lateral stripe, and flecks of red are found on the supra-labials at the angles of the jaw. The small spots on the medial edge of the parietal scales are red rather than the usual yellow. The vividness of the color makes the snake easily recognizable at a considerable distance.—HORACE N. MARVIN, Department of Zoology, University of Wisconsin, Madison, Wisconsin.

NOTES ON TWO SPECIES OF DESERT TOADS.—Between June 12 and July 28, 1939, the writer made trips every other night to study the nocturnal reptile life along a 5 mile strip of black asphalt highway between Esquele and the San Xavier Mission, southwest of Tucson, Arizona. The activities of two local species of toads in relation to the summer rains were observed.

Bufo alvarius Girard.—The first individual of this species was seen along the road on the night of June 22. At that time no rain had fallen in that particular section for at least two months. Other toads of this species were seen along the same road on the nights of June 26, and June 29. The first light rain of the summer commenced at about 9:00 P. M. on the night of July 1. Later that evening, at about 2:20 A. M. on July 2, four *Bufo alvarius* were seen. Between 12:30 and 1:00 A. M. on the morning of July 4, additional individuals were abroad. Although the activities of this species seemed to be stimulated by the beginning of the summer rains, the wet weather was not responsible for their appearance.

Scaphiopus couchii Baird.—This species was not seen along the road until the night of the first heavy summer rain. After the first light showers, July 1 and 2, no specimens were observed. On the following nights heavier rains fell. These filled the dips and depressions and drenched the ground. During the evening of July 3, and the early morning of July 4, when the air temperature was about 73°F., the moist soil temperature near 72°F., and the relative humidity at 78, hundreds of this species were milling about in the flooded dips and washes, many of them in copulation. As this species did not appear before the summer rains and did not come out immediately after the first light rains on the night of July 1, I infer that thorough moistening of the soil is necessary for their appearance in unison and in such abundance.—LEE W. ARNOLD, University of Arizona, Department of Entomology and Economic Zoology, Tucson, Arizona.

NOTES ON YOUNG RUBBER SNAKES.—Tanner and Tanner (1939, Great Basin Naturalist, 1:27-30) were the first to report on the birth of rubber snakes, *Charina bottae* (Blainville). They found that in Utah the young are born alive in September. From examination of specimens, the size of the eggs and development of embryos seem to indicate that young might also be produced in the spring. They surmise that due to the small size of the young snakes, their food must be other than mammalian. I have the following notes on young rubber snakes born in captivity. Mr. Sam Nichtami caught a female rubber snake in the woods near Cle Elum, Washington, on September 15, 1941, and took it to his high school teacher, Mr. Ellsworth Lumley. On either September 20 or 21, four young rubber snakes were born. These were turned over to me by Mr. Lumley on September 24 and at that time they measured 215, 220, 220 and 225 mm. and weighed 7.2, 7.4, 7.6 and 7.2 grams respectively. The dorsal surface was the color of an earthworm while the underside was a more intense pink. A remnant of the yolk stalk was still present on the ventral side somewhat posterior to the center of the body. They were all quite active. One of them shed its skin on September 30 and the other three shed on the following day. Insects and worms placed in the terrarium were not taken. Force feeding with small pieces of liver placed in their mouths by means of forceps was not always successful, for they were likely to disgorge it. On October 28, 29 and 30, three of the snakes shed their skins again and on March 6, 1942, one of them shed for the third time. They lost weight gradually but continuously. By the second week of March they had all died. At this time their increase in length had amounted to 50 to 100 mm.—ARTHUR SVIHLA, University of Washington, Seattle, Washington.

DIURNAL ACTIVITY OF *CROTALUS CERASTES*.—On October 18, 1941, at 9:30 A. M., while I was watching the activities of *Uma inornata* on the sand dunes of the Coachella Valley, California, an adult *Crotalus cerastes* appeared in the field of vision of the field glass. This animal is essentially nocturnal or crepuscular in habit. Since the day was warm and bright, this diurnal activity appeared to be unusual. The snake was sidwinding across a bare patch of sand between low-growing bushes. Two juvenile *Uma*, apparently attracted by the movement, dashed in its direction. One of them approached within 5 or 6 inches. It paused, glanced at the reptile, then scurried away. The rattler paid no attention to the lizards. The snake was followed with care to avoid

startling it; it followed a circuitous route, showing little selection with respect to shaded patches and open sunny areas of sand.

It was noticed that the snake readily switched from a position of locomotion with the body looped forward on the right of the head to one in which the loop was on the left and vice versa. This interchange was made smoothly, without any apparent break in progress.

Ultimately my presence was detected, apparently through the sense of smell. The snake approached within less than 2 yards of my feet. I stood perfectly motionless to avoid attention by movement. It passed to one side without any change in behavior until it reached a point about 8 feet beyond my position. There the snake suddenly became alert and began to rattle. Facing in my direction, it retreated slowly backwards into the shelter of a bush. There was a slight breeze blowing from me toward the reptile.

—ROBERT C. STEBBINS, *Department of Zoology, University of California at Los Angeles, California.*

DEFENSIVE BEHAVIOR OF THE RUBBER SNAKE.—Various species of blunt-tailed snakes are known as "two-headed" snakes in the several regions of the world in which they occur. This is due not only to appearance, but also to the behavior of these animals, since they may elevate the tail while the head lies motionless. The tail may bear conspicuous markings, or possess coloration similar to that of the head.

Examples of such "two-headed" snakes are found in the genera *Cylindrophis*, *Doliophis*, *Calamaria*, *Apostolepis*, and *Charina*. In addition to elevating the tail in a threatening manner, some species may actually "strike" with the tail, by swinging it spasmodically about when touched. This habit has been recorded by Barbour (1926, *Reptiles and Amphibians*: 50, fig. 45-46) for *Cylindrophis*, and by Pope, as reported by Schmidt (1927, *Bull. Amer. Mus. Nat. Hist.*, 54: 538), for *Calamaria*.

Similar behavior was exhibited by several specimens of *Charina bottae* (Blainville) kept in this laboratory. These snakes, when irritated, held the blunt tails partially coiled and elevated. If the body, particularly the posterior portion, was touched, the tail immediately swung about, uncoiled, and its end would tap the offending object with a "striking" motion. During this process the animal never attempted to bite, or to strike with its head. Schmidt and Davis (1941, *Field Book of Snakes*: 100) refer to this habit, but cite no specific observation.—HUGH L. KEEGAN, *Zoological Laboratory, State University of Iowa, Iowa City, Iowa.*

THE COMMON PINE SNAKE IN WEST VIRGINIA.—In June, 1940, Mr. Dewitt Shaver, a graduate student at Virginia Polytechnic Institute, collected a specimen of the common pine snake, *Pituophis melanoleucus melanoleucus* (Daudin), in West Virginia. The snake was taken about 2 miles southwest of Waiteville, in Monroe County. Another specimen was observed dead along the road but was not collected. The specimen has been deposited in the Carnegie Museum (CM 21265) and Mr. M. Graham Netting writes that it is a male, with a total length of 1472 mm.; tail length 201 mm.; dorsal scale rows 27-29-21; ventrals 216; caudals 58; anal undivided. Mr. Netting informs me that this species has been recorded from four Virginia counties contiguous to West Virginia, namely: Bath (Stull, 1940, *U.S.N.M. Bull.* 175: 59), Shenandoah (Dunn, 1936, *List of Va. Amphibians and Reptiles*, mimeographed), Craig and Giles (Burch, 1941, *Virginia Wildlife*, 4: 69). A photograph in the U. S. Biological Survey (U. S. Fish and Wildlife Service) collection shows a specimen taken on the east side of Massanutten Mountain near Kennedy's Peak in Shenandoah County. Another specimen (U. S. Biological Survey H 5487) deposited in this same collection has no exact locality but was taken in the George Washington National Forest. I can add an additional locality—Big Levels, Augusta County, Virginia—from personal knowledge. It is apparent, therefore, that this snake is well distributed along the Virginia side of the Virginia-West Virginia boundary, and while Mr. Shaver's specimen is the first definitely known to have been secured in West Virginia, the species has long been expected to occur in that state and it is probable that it will be collected eventually in most of the boundary counties from Monroe to Hardy.—LEONARD M. LEWELLYN, *Fish and Wildlife Service, Patuxent Research Refuge, Bowie, Maryland.*

Ichthyological Notes

DISTRIBUTIONAL NOTES ON THE FISHES OF LOWER CALIFORNIA AND THE WEST COAST OF MEXICO: II.—These notes are an addition to those published in COPEIA (1938 (3): 128-131). The fish were collected by the methods described in that paper and in COPEIA (1941 (1): 44) except for *Girella simplicidens* Osborn and Nichols which was collected by a group from Stanford University near the head of the Gulf of California.¹ Other than the latter, the species listed here were collected during the winter of 1940 from Cape San Lucas, the west coast of Mexico, and islands offshore.

For each species listed the known range is given first, in parentheses, as determined from the available literature, followed by the extension in range as indicated by the present collection. Sometimes the collection of a species is recorded because it is rare or of interest even though no extension in range has been found. Range extensions of species that are definitely known not to represent strays but established populations are listed with an asterisk. Species listed without this mark may also represent established populations in the locality of collection. Information regarding the presence of populations was obtained through submarine observation by means of diving apparatus.

BELONIDAE

1. *Strongylura pterurus* Osborn and Nichols.—(Gulf of California): Socorro Island (Lat. 18° 44' 30" N. Long. 110° 59' 30" W.) and Puntarenas, Costa Rica.

SYNGNATHIDAE

2. *Doryhamphus melanopleura* (Bleeker).—(Galapagos Islands and Lower California to Japan): Socorro Island.

PSEUDOCROMIDAE

3. *Pseudogramma thaumasium* (Gilbert).—(Panama): Maria Magdalena Island, Tres Marias group (Lat. 21° 25' N., Long. 106° 23' W.).

GIRELLIDAE

4. **Girella simplicidens* Osborn and Nichols.—(Upper portion of the Gulf of California.) This species was taken in abundance by poisoning a large tide pool at Punta Penasco, Sonora, Mexico (Lat. 31° 18' N., Long. 113° 35' W.). It apparently occupies an ecological niche similar to that of *Girella nigricans*, the young of which are abundant in tide pools.

CIRRHITIDAE

5. **Cirrhitichthys corallicola* Tee Van.—(Sihuatanajo, Mexico to Gorgona Island): Tres Marias Islands and Cape San Lucas, Lower California (Lat. 22° 52' 30" N., Long. 109° 53' 45" W.). This species is close to *Cirrhitichthys aprinus* of the Indo-Pacific, appearing to differ in the possession of a few more scales in the lateral line (*C. corallicola* 43-45, *C. aprinus* 39-41).

ACANTHURIDAE

6. **Acanthurus triostegus* (Linnaeus).—(Australasia, Polynesia, Revillagigedo and Cocos Islands): Maria Magdalena Island, Tres Marias group. It is likely that this species will be found on the west coast of Mexico proper.

ELEOTRIDAE

7. *Eleotris pictus* Kner and Steindachner.—(Sonora south to Panama): fresh water, Cleopha Island, Tres Marias group (Lat. 21° 17' N., Long. 106° 15' W.).²
8. *Gymneleotris seminuuda* (Günther).—(Panama and Acapulco): tide pool, Cleopha Island, Tres Marias group.

GOBIIDAE

9. *Coryphoterus urosphilus* Ginsberg.³—(Pearl Island, Panama, and Tiburon Island, Gulf of California): Socorro Island.

CLINIDAE

10. **Enneaptergius carminalis* (Jordan and Gilbert).—(Mazatlan, Mexico): Tres

¹ I wish to thank Miss Margaret Storey of the Natural History Museum, Stanford University, for the privilege of examining this collection.

² These islands reported to lie 3 miles farther east than shown on the chart from which this position was taken.

³ Identification confirmed by Mr. Isaac Ginsburg.

Marias Islands and Socorro Island. One individual from Socorro Island has the area between throat and ventrals completely scaled; there are fewer scales in the lateral line (30-32) and the last dorsal has eight instead of nine rays. An examination of the gonads of specimens from the Tres Marias disclosed both male and female fish, eliminating any possibility that *E. carminalis* and *E. storeyai* are the different sexes of the same species.

11. **Enneaptergius storeyai* Brock.—(Los Frailes, Lower California, Lat. 23° 22' 15" N., Long. 109° 25' W.⁴): Tres Marias Islands and Socorro Island. Individuals from Socorro Island have a few more scales in the lateral line (37) and one or two more rays in the second dorsal. This species and *E. carminalis* were taken together with fish poison in water 20 to 30 feet deep.—VERNON E. BROCK, *Fish Commission of Oregon, Portland, Oregon*.

FALL SPAWNING OF THE MUD PICKEREL, *ESOX VERMICULATUS* LE-SUEUR.¹—A comparison of very small mud pickerel collected by us in the fall with specimens in the collection of the University of Michigan Museum of Zoology indicates that this fish, which ordinarily spawns in the spring, may also spawn in early autumn. Evidence that fall spawning occurs follows: (1) during early June spring-spawned specimens approximate the length of our November young (Table 1); (2) the smallest individuals collected in early May as well as the smallest of ours, apparently contain yolk; (3) among the mud pickerel collected by us in November were both spring- and fall-spawned young of the year and, in addition, some older fish: twelve fall-spawned individuals that averaged only 27.7 mm. in standard length, three spring-spawned individuals (scales lacking annuli) that averaged 113.5 mm., and nine older fish (with one annulus or more) that averaged 170.9 mm. and ranged from 129.5 to 213.5 mm.; (4) a mud pickerel young collected in mid-August (Table 1) had attained a size of 50.0 mm. which is greater by 14.0 mm. than any of the small young that we collected in November.

TABLE 1
SIZE OF YOUNG OF YEAR MUD PICKEREL ON VARIOUS DATES IN SOUTHERN MICHIGAN

Date of Collection	No. of Specimens	Average Standard Length (mm.)	Range in Standard Length (mm.)	County
V:19:1927	8	19.6	15.0-36.0	Branch
V:24:1927	20	25.3	20.0-32.0	Branch
VI:3-5:1927	10	28.9	22.0-36.0	Branch
VI:14:1930	4	32.0	27.0-36.0	Livingston
VII:12-13:1927	3	45.0	45.0-45.0	Oakland
VIII:13:1926	1	50.0	. . . . .	Washtenaw- Livingston
XI:18:1941	3	113.5	91.0-135.0	Washtenaw
XI:18:1941	8	26.8	19.5-36.0	Washtenaw
XI:20:1941	4	29.4	26.0-32.0	Washtenaw

Our collections were made on November 18 and 20, 1941, in a tributary of Fleming Creek, Washtenaw County, Michigan. The museum specimens with which the comparisons have been made were from other southern counties in the same state.

No facts obtained support the idea that the small size of the fall-spawned young was due to parasitization, competition, or cannibalism. It seems likely that the unusually warm weather in October may have initiated spawning. Some spring-flowering plants, *Forsythia*, for example, blossomed in the same fall in this region.

Dr. Carl L. Hubbs has told us that the late Professor T. L. Hankinson also caught obviously fall-spawned mud pickerel in Fleming Creek.—KARL F. LAGLER, *Department of Zoology*, and CLARK HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan*.

⁴ Type locality: Brock, 1940. *Stanford Ichthy. Bull.* 2 (1).

¹ Contribution from the Department of Zoology, University of Michigan.

THE ROCK BASS, *AMBLOPLITES RUPESTRIS*, IN WASHINGTON STATE.—In his list of "Alien Fishes in the Waters of the Pacific Northwest" (Calif. Fish and Game, 28 (1), 1942: 9-15) Chapman makes no mention of the rock bass, *Ambloplites rupestris*; neither is it included in Schultz' and DeLacy's catalogue of the fishes of Washington and Oregon (Mid-Pacific Magazine, 1935 and 1936) nor in Schultz' "Keys to the Fishes of Washington, Oregon and Closely Adjoining Regions" (U. Wash. Publ. Biol., 2, (4) 1936: 103-228). Some account of the establishment of this species in the Puget Sound basin of Washington is therefore in order.

Specimens from three lakes, American and Steilacoom in Pierce County and Saint Clair in Thurston County, are in the collection of the writer. In American and Saint Clair the species is now abundant and forms a considerable part of the total annual catch. Conditions in Steilacoom Lake are less well known: the only specimen seen to date was caught June 8, 1937, from the head of Chambers Creek near where it leaves the lake, and lay reports indicate that occasional catches are still being made from both the lake and creek. Anglers' reports of this fish in other lakes of Pierce and Thurston counties have been twice disproven while others remain in doubt. A few rock bass have been taken in Patterson Lake, Thurston County, following the transplanting of 18 fish from Lake Saint Clair in June, 1939 (according to F. A. Mullen, resort owner on Patterson Lake).

The source of the stock and the date and site of the first introduction of rock bass in this area are at present unknown, although indications are that it was in American Lake, at some time prior to 1929. This was in the days of county rather than state fish and game control, the records of the various county departments being now difficult or impossible of access. Apparently the bass did not become generally distributed and abundant throughout American Lake until about five years after that date, and at two resorts on Saint Clair where I occasionally fished they were entirely unknown until about 1935. In both lakes the numbers of the fish are apparently still increasing, the complaint being made at Saint Clair that there seems to be a correlated decrease in the numbers of large-mouthed bass (*Huro salmoides*).

Fishermen in this region generally comment favorably on the game and food value of this little panfish. By far the largest example reported to me was one 14 inches long caught by C. B. Dinsmore at American Lake in 1929. A specimen taken June 8, 1937, from the outlet of Steilacoom Lake, although measuring only 106 mm. in total length, was sexually mature and contained a quantity of ripe ova.

It may be worthy of notice that the lakes in which the rock bass is known to have established itself in this area are all located on the extensive glacial outwash plains at the southern end of the sound.—JOHN W. SLIPP, *University of Washington, Seattle, Washington*.

ON *PLEUROGOBIUS*, A TYPOGRAPHICAL ERROR.—In 1909 Alvin Seale described a new species of goby as *Pterogobius boulengeri*, but the printer changed it to *Pleurogobius*. The proof reader failed to catch this error, and so it appeared in print as *Pleurogobius boulengeri* in the Philippine Journal of Science (4, 1909: 536). When writing my book on Philippine gobies I failed to find any diagnosis of *Pleurogobius* and an examination of Seale's specimen and of his manuscript notes revealed that he had written *Pterogobius*. As the specimen evidently did not belong to Gill's *Pterogobius*, I created the genus *Cingulogobius* for it.

Now Schultz, in his *Fishes of the Phoenix and Samoan Islands*, has revived the mythical genus *Pleurogobius*, which has never been defined and exists merely as a printer's error. There is no justification therefore for *Pleurogobius*, and *Pleurogobius naraharæ* as given by Schultz (U. S. National Museum Bulletin 180: 239).—ALBERT W. C. T. HERRE, *Stanford University, California*.

RAIA STELLARIS, A NEW NAME TO REPLACE *RAIA TEXANA* LERICHE.—Leriche, in "Le Synchronisme des eocenes marines, des deux cotes de l'Atlantique, d'apres leur faune ichthyologique," (1940, C. R. Acad. Sci. Paris, 210: 590) proposes the name *Raia texana* Leriche for a fossil ray from "La formation de Midway, dans la portion meridionale de Atlantic et Gulf Coastal Plain (de l'ouest de la Georgie au Texas)." This name, however, is preoccupied by *Raia texana* Chandler (1922, Proc. U.S.N.M. 59: 657-8) for a recent ray from the Texas coast. I propose, therefore, that Leriche's specimen be renamed *Raia stellaris* (Leriche), thus again, in slightly different form, honoring the Lone Star State.—J. L. BAUGHMAN, 311 Peden Ave., Houston, Texas.

REVIEWS AND COMMENTS

THE OVERFISHING PROBLEM.—By E. S. Russell. Cambridge University Press, 1942: i-viii, 1-128, 16 figs.—In this series of five lectures delivered at Johns Hopkins University early in 1939, Mr. Russell has given a masterly brief summary of the history, problems, aims and results of marine fisheries investigations.

If there is a moral to this book it is that the over-fishing problem is appallingly complex. This fact is ignored all too frequently by those administrators who pursue conservation by the method of hoarding. This economically bad practice has only the doubtful advantage of being relatively easy, particularly when compared with that more sophisticated, though elusive, goal of fishery research, the optimum catch.

The history of the various sea fisheries has followed a regular pattern, characterized by a period of tremendous expansion, brought about by mechanization. After a certain point, this expansion has been accompanied by a decrease in catch per unit, which has necessitated improvements in mechanization and extension of the fishing grounds. During the last war, fishing activities in the North Sea declined to a very low level, permitting the fish populations to increase in abundance. The war's end found the catch per unit of effort very much improved; but fishing continued to expand, and in a short while, the beneficial effect of the hiatus was obliterated for want of adequate management practice. The end of the present war should offer a second such golden opportunity. This time, knowledge of fishery biology, as set forth in Mr. Russell's book, is far ahead of where it was in 1918. It will be interesting to see what use will be made of it, and what the effects will be.—L. A. WALFORD, *Stanford University, California*.

FISHES OF THE PHOENIX AND SAMOAN ISLANDS COLLECTED IN 1939 DURING THE EXPEDITION OF THE U. S. S. "BUSHNELL." By Leonard P. Schultz. Bull. U. S. Nat. Mus., 180, 1943: i-x, 1-316, pls. 1-9, figs. 1-27. \$0.65.—When any ichthyologist first undertakes the study of the vast Indo-Pacific fauna, with its endless array of species and its large and scattered literature, it is inevitable that he will reach some systematic conclusions which will be queried by fellow workers, and that he will miss some observations and references. Under these circumstances Schultz, in his report on the fishes of the Phoenix and Samoan islands obtained by himself in 1939, and by other collectors in previous years, seems to have done a very creditable job. The field, however, is one that calls for intensive specialization, such as it has never received.

Despite various difficulties Schultz succeeded in collecting from the reefs, lagoons and streams of the islands visited 221 kinds of fish, of which 30 are described as new. Six new genera are named. Perhaps the most spectacular find was a curious little freshwater goby, *Fagasa tutuila*. *Dermosteira dorotheae* is indicated as a very distinct new type of the Callionymidae.

The numerous keys are often complicated and lengthened by nonalternative characters which most authors would have relegated to the species accounts. For a number of groups there are included frequency tables of fin-ray and gill-raker counts, even when the species do not differ or are each represented by only one or a few specimens.

In his descriptions of the species of Gobiidae and Eleotridae Schultz, without comment, includes fin formulae that differ from those in general use. By these formulae he indicates that the first ray of the second dorsal fin and of the anal fin is a spine. I had recently and independently come to that conclusion, and had checked the finding by dissection and microscopic examination on a considerable number of genera and species. No exceptions were found.

There are included some habitat notes and some descriptions of life colors; also new statistical data on the flight of fishes.—CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

MIOCENE FISHES OF SOUTHERN CALIFORNIA. By Lore Rose David. Special Papers of the Geological Society of America, 43, 1943: i-xiii, 1-193, pls. 1-16, figs. 1-39.—Thanks to the researches of David Starr Jordan and of Lore Rose David, the Miocene marine fish assemblages of southern California now rank among the best known of all described fossil fish faunas. Dr. David's monograph comprises six essays. The first two deal with Upper Miocene fishes of the Santa Monica Mountains, referred respectively to the Lower and the Upper Modelo Formation. These are largely new faunas. The most spectacular discovery is that of *Laytonia*, a new type of the Halosauridae. The Modelo fish associations are interpreted as those of a warm-temperature sea, of an open shore, and of moderately to rather deep water. Both bottom and free-swimming types are represented. The third part treats a new Miocene fish fauna from the rocky shore of Palos Verdes Hills. Six species only are represented, including two new ones, referred respectively to *Pteroplatea* and *Opisthonema*. They are supposed to have lived in a shallow, marine basin, when the climate was warmer than it is now. The fourth part is a review of the Miocene Clupeidae of California. *Xyne grex*, the herring which once perished in unbelievable millions, is redescribed in particular detail. Part V is a treatment of the Zaphlegidae, an extinct family referred to the trichiuriform scombroids and characterized particularly by the arrangement of the interneurals. I query this indication of relationships: the Zaphlegidae may well represent another offshoot of the percoids adapted for rapid movement in open water. The zaphlegids seem to me to have been pelagic rather than deep-sea fishes. The final part deals with the best known of the assemblages, that of the diatomaceous earth deposits at Lompoc. Species named by Jordan and by Jordan and Gilbert are redescribed, along with one new genus and two new species (although it is stated that no new ones are named). The Lompoc fish fauna is thought to have lived within a half mile of shore in warm-temperature or subtropical water, from 25 to 50 fathoms deep.

The extinction of many elements of these Miocene faunas is attributed in part only to a gradual cooling of the seas. The opinion is expressed that the changes were probably due in large measure to local causes. Some of the fishes of the California Miocene are thought to be represented by genera now living along the Atlantic Coast. "The recent California fish fauna has evolved from those elements which survived the Miocene extinction plus incoming northern or western Pacific (Japanese) forms."

Dr. David's approach contrasts in some ways with that of Jordan. She properly lays more stress on osteological detail, less on the impressionistic method (of which Jordan was the master). Jordan erected new genera for most of his species, often without adequate technical differentiae; David swings to the other extreme, synonymizing many of Jordan's genera with Recent ones, and recognizing only those that are very trenchantly distinguished. In this course I would not have gone so far, for some of the genera thus synonymized do have distinctive features. When doubt clearly remains, it would have been better, I think, to have followed the principle of systematic work which calls for the maintenance of the *status quo*, except when a change is clearly called for. David's treatment of genera is inadequate: due to the lack of definite diagnoses and genotype designations it may even be questioned whether the new generic names are available, under the Rules. There are a number of discrepancies between different parts of the text, and between the text and the tables and figures. We should all be very thankful, however, for the light which Dr. David's long and painstaking studies have shed on the taxonomy of the California Miocene fishes, and on their habitats and life ways.—CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

CANADIAN FISHERIES MANUAL—1942. By Frederick William Wallace. National Business Publications, Gardenvale, Quebec, 1942: 1-102, 1-116, plates, figures. \$3.00.—It is news when the commercial fishing industry prepares an informative book of value to fisheries biologists. The procedure is usually reversed. F. W. Wallace has had considerable practical and executive experience with fisheries both in Canada and the United States for more than 30 years, and has attempted to portray the fishes, fishing grounds, methods of capture and preparation for market, and economic importance of the Canadian commercial fisheries. In this he has drawn a most excellent picture, by word and photograph.

About one-half of the book is devoted to space in which individual companies outline their methods of production and processing, and the reviewer received the impression that technological advances in gear and over the weather have played a greater rôle in yield than have the discreetly unmentioned restrictions of governmental agencies. More information may be gleaned from the excellent advertisements than from parts of the text proper. The remainder is intended to provide a source of information for students and teaching staffs in schools and colleges, and to Wallace's own observations have been added those of scientific investigators. About 60 species or groups of marine and freshwater fish and shellfish are discussed in order of economic importance.

It is to be regretted that the scientific names had not been submitted to an authority for revision, that the figures of pickerel and sauger were not interchanged, and that some substitution had not been made for the freak *Ameiurus vulgaris*. Illustration of gear and methods of use constitute a large part of the usefulness of the book, and an index has been included.—KENNETH H. DOAN, *F. T. Stone Laboratory, Ohio State University, Put-In-Bay, Ohio.*

A HISTORY OF SCIENCE. By Sir William Cecil Dampier. The Macmillan Co., New York, 1942 (Third Edition): i-xxiii, 1-546, 18 figs. \$2.95.—The title "History" in college catalogues or on the covers of school books, has come, generally, to connote accounts of politics or the origin, course and aftermath of wars. Dampier's great and scholarly work proves that the story of man's learning has far more significance to world history than that of those other, more dismal pursuits. This is an impressive fruit of imposing learning and scholarship. Its scope ranges from the dawn of recorded history to today, and covers all branches of learning, up to and including modern physics. Its treatment is brief—it has to be in less than 600 pages. The wonder of it is that the author has found room for several paragraphs on Ichthyology, Fisheries Research and Oceanography.—L. A. WALFORD, *Stanford University, California.*

NEW BOOKS RECEIVED

STUDIES ON THE ORIGIN AND EARLY EVOLUTION OF PAIRED FINS AND LIMBS. Part I. Paired fins and girdles in Ostracoderms, Placoderms, and other primitive fishes. Part II. A new restoration of the skeleton of Eusthenopteron (*Pisces Crossopterygii*, Devonian, Quebec) with remarks on the origin of the Tetrapod stem. Part III. On the transformation of pectoral and pelvic paddles of Eusthenopteron type into pentadactylate limbs. Part IV. A new theory of the origin of the pelvis of tetrapods. By William K. Gregory and Henry C. Raven. *Ann. New York Acad. Sci.* 42 (3): 273-360, 34 figs., 5 plates.

AN ANALYSIS OF THE LOCOMOTION OF THE SEAHORSE, *HIPPOCAMPUS*, BY MEANS OF HIGH SPEED CINEMATOGRAPHY. By C. M. Breder and H. E. Edgerton. *Ann. New York Acad. Sci.* 43 (4): 145-172, 5 figs., 4 plates.

POISONOUS REPTILES OF THE WORLD: A WARTIME HANDBOOK. By Doris M. Cochran. *Smithsonian Institution War Background Studies*, Publ. 3727 (10), 1943: 37 pp., 17 pls.

EDITORIAL NOTES AND NEWS

Members in Armed Services

CHANGES in rank, additions and corrections to the list of our members serving in the United States armed forces, as published in our last issue, follow. Starred names indicate overseas service.

*BLKS, CAPT. P. S., U.S. Army; *STAFF SGT. BRYCE C. BROWN, Army Medical Corps.

*FLURY, ALVIN F., U.S. Navy.

KEEGAN, LT. HUGH L., Army Medical Corps.

MANVILLE, LT. RICHARD H., Army Medical Corps.

OLIVER, ENSIGN JAMES, U.S. Navy.

REICHELDERFER, THOMAS, U.S. Army; REYNOLDS, ALBERT E., Army Air Corps.

SNYDER, LT. RICHARD C., U.S. Army; STONE, LT. FRED L., U.S. Marine Corps.

WOOD, LT. SHERWIN F., U.S. Naval Reserve, Medical Corps.

News Notes

DR. DORIS M. COCHRAN, a member of the staff of the U.S. National Museum since 1919, has been appointed associate curator in charge of the division of reptiles and amphibians of that institution. DR. WALDO L. SCHMITT, curator of marine invertebrates, has been selected to succeed DR. LEONHARD STEJNEGER as head curator of biology.

The Board of Trustees of the Catholic University of America have recently conferred the title of Professor of Biology, Emeritus, on DR. J. B. PARKER, whose paper on "The Reproductive System of the Brown Trout" appears in this issue.

ALFRED C. WEED, who has served the Field Museum of Natural History as curator of fishes for twenty-two years, was honored by his fellow workers by a farewell reception on his retirement on April 30.

The University of California has conferred an honorary degree on PROFESSOR SAMUEL J. HOLMES, Emeritus.

DR. E. R. DUNN, accompanied by MRS. DUNN, left June 20 for a year of study of the herpetological fauna of the temperate zone of the eastern Andes in Colombia, under the auspices of the Committee for Inter-American Artistic and Intellectual Relations. Dr. Dunn will have headquarters at the Instituto de Ciencias Naturales, Bogotá.

A group of United States zoologists have formed a General Council on Zoological Nomenclature (A) To act in an advisory capacity in all matters concerning zoological nomenclature during the World War and for such time thereafter as it may seem desirable. (B) To administer, amend, interpret, and maintain a code of nomenclature for the use of zoologists. (E) To cooperate with zoologists practised in nomenclature who are residents of foreign countries when the war is ended or as soon thereafter as may be practicable. DR. WILFRED H. OSGOOD will act as Secretary, and KARL P. SCHMIDT is a member of the Council.

A Guggenheim fellowship has been awarded to DR. TILLY EDINGER, research associate in paleontology at the Museum of Comparative Zoology, to carry on a paleontological study of the tooth development in amphibians and reptiles, particularly primitive fossil types, with special reference to the history of dental succession in the evolutionary line leading from ancestral fishes to mammals.

The American Museum of Natural History has recently reorganized their Department of Experimental Biology. The name has been changed to the Department of Animal Behavior: staff members include DR. ALBERT P. BLAIR, Assistant Curator, and DR. CHARLES M. BREDER, JR., Research Associate.

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